Table of Divisions

Division 02 – Existing Conditions

SECTION 02 41 13

SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Remove site structural and site utility items and dispose of them off site.

2. Salvage.

1.2 REFERENCES

A. Related Requirements:

1. Section 01 11 00 “Summary”: Limitations on CONTRACTOR’s use of site and premises.

2. Section 01 11 00 “Summary”: Description of items to be salvaged or removed for re-use by CONTRACTOR.

3. Section 01 57 00 “Temporary Facilities and Controls”: Site fences, security, protective barriers, and waste removal.

4. Section 01 66 00 “Product Requirements”: Handling and storage of items.

5. Section 01 78 50 “Closeout Procedures”: Project conditions; protection of benchmarks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

6. Section 31 11 00 “Site Clearing”: Vegetation and existing debris removal.

1.3 SUBMITTALS

A. Not Applicable.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 ENVIRONMENTAL AND PERMIT REQUIREMENTS

A. Obtain project environmental impact review from OWNER prior to start of work.

B. Obtain necessary permits and comply with environmental regulations and applicable codes during the demolition process.

1.7 WORKER SAFETY AND TRAINING

A. Ensure all workers involved in the demolition process receive appropriate safety training and adhere to all OSHA regulations and guidelines.

B. Train workers in handling of hazardous materials, fall protection, and use of personal protective equipment (PPE).

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

A. Review all work procedures with ENGINEER and with representatives of any utility in the work zone.

B. Locate and preserve all active utilities which are to remain in service.

C. Implement traffic control plan requirements, Section 01 55 26 Traffic Control.

3.2 PROTECTION

A. Protect irrigation systems.

B. Protect structures to be removed and their contents from vandalism and theft.

C. Protect trees:

1. Avoid or minimize damage to trees and tree roots.

2. Provide certified arborist observation of root cuts larger than four (4) inches diameter. Roots provide anchorage, storage of energy, and absorption and conduction of water and mineral elements. Loss of root connection affects health and stability of tree and safety of people and property. Notify ENGINEER of such root cut.

D. Protect the Environment:

1. Control dust, Section 01 57 00 Temporary Controls.

2. Protect plant and animal habitats.

3. Protect migratory birds. Removal of trees and shrubs during bird nesting season will require a nest survey by a qualified biologist.

E. Protect water resources:

1. Control stormwater runoffs from disturbed areas. Follow federal, state, and local regulations.

F. Repair or replace damage at no additional cost to OWNER.

3.3 STRUCTURE DEMOLITION

A. Remove structures and incidentals such as foundations, fences, outbuildings, etc. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.

B. Provide demolition sequencing plan for review by ENGINEER for structures required to be removed.

C. Provide, erect, and maintain temporary barriers and security devices.

D. Conduct operations to minimize effects on and interference with adjacent structures and occupants.

E. Do not close or obstruct roadways or sidewalks without permit.

F. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.

G. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.

H. Do not begin removal until receipt of notification to proceed from OWNER.

I. Protect existing structures and other elements that are not to be removed.

   1. Provide bracing and shoring.

   2. Prevent movement or settlement of adjacent structures.

   3. Stop work immediately if adjacent structures appear to be in danger.

J. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

K. Remove floor slab or break it into pieces no larger than three (3) feet square.

L. Remove structures so that no remaining portion is closer than three (3) feet to any water course or closer than two (2) feet to the Subgrade and Embankment surface, or within two (2) feet of the natural ground surface. Excavation shall be confined, whenever feasible, within a maximum distance of two feet from the foundation perimeter and should not exceed a depth greater than six inches below the foundation level to minimize soil disturbance.

M. Backfilling and compaction of excavations for structures, Section 31 23 23 Backfilling for Structures.

N. Building components, Section 02 41 19 Selective Building Demolition-Alterations.

3.4 PIPELINE DEMOLITION

A. General:

1. Abandoned pipelines not to be salvaged are considered as incidental excavation work, Section 31 23 16 Excavation.

2. Do not damage pipe or structures that remain in service or are to be salvaged for OWNER.

B. Gravity Pipe Demolition:

1. Plug abandoned pipe with a permanent, water-tight concrete plug extending into the abandoned pipe at least two (2) feet.

2. Seal openings in walls of remaining manholes, catch basins, or structures with water-tight plugs.

C. Pressure Pipe Demolition:

1. Coordinate demolition with ENGINEER and agency owning the utility pipe.

2. Plug abandoned pipe with a permanent water-tight plug.

3. Cap and restrain the active pipe with a blind flange or equivalent type of plug.

4. For service line demolition or abandonment, disconnect the line from the mainline and shut off the corporation stop.

3.5 BURIED FUEL TANK DEMOLITION

A. Coordinate with UTA Environmental.

B. Comply with the local authority having jurisdiction over fuel tank removals.

C. Remove buried fuel storage tanks and dispose of tank contents in accordance with Laws and Regulations.

D. Do not spill fuel on Subgrade.

3.6 MISCELLANEOUS DEMOLITION

A. Remove miscellaneous structures and obstructions or cover them with backfill if the result meets the following requirements:

1. Backfill is stable.

2. Burial does not interfere with construction.

3. Permission to do so is obtained from ENGINEER.

4. No remaining portion is within two (2) feet of the final ground surface contours.

3.7 SALVAGE

A. Remove existing bridges and abutments indicated.

B. Salvage designated equipment and materials for OWNER.

C. All other material becomes the property of CONTRACTOR unless such materials are not owned by OWNER.

3.8 HAZARDOUS MATERIALS IDENTIFICATION AND HANDLING

A. Coordinate with UTA Environmental.

B. Conduct surveys to identify hazardous materials, such as asbestos, lead-based paint, or contaminated soil and groundwater.

C. Handle and dispose of hazardous materials in compliance with applicable regulations under the guidance of a licensed professional, Section 02 60 00 Contaminated Site Material Removal.

3.9 EXISTING UTILITIES

A. Notify and coordinate with neighboring properties, utility companies, and other stakeholders affected by the demolition activities. Obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to OWNER.

E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to OWNER.

F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

H. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

3.10 SITE RESTORATION

A. Following demolition, restore the site through grading, erosion control measures, and revegetation as required.

3.11 DEMOLITION WASTE MANAGEMENT

A. Handle, recycle, and dispose of demolition waste in accordance with local, state, and federal regulations.

END OF SECTION

SECTION 02 41 14

PAVEMENT REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Remove roadway Pavement.
2. Remove curb, gutter, sidewalk, Driveway Approach, waterway, and similar flat work.
3. Remove pavement markings and traffic control devices related to the removed pavement.

1.2 REFERENCES

A. APWA (Utah) Standards Plan 256 Concrete pavement patch.

B. APWA Specifications 00 72 00 Section 6.18 Hazardous Waste Generation for removal and handling of hazardous waste.

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26 Traffic Control.

B. Hazardous materials survey report and disposal plan (if applicable).

C. Site restoration plan including grading, erosion control, and revegetation measures (if applicable).

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26 Traffic Control.

B. Coordinate utility locations, Section 01 31 13.

C. Preserve all active utilities.

D. Notify neighborhood at least 48 hours before day and time of operation.

E. Mark existing utilities on redline drawings.

3.2 PROTECTION

A. Install Invert Covers, Section 01 71 13.

B. Trees:

1. Avoid or minimize damage to trees and tree roots.

2. Provide certified arborist observation of root cuts larger than four (4) inches diameter. Roots provide anchorage, storage of energy, and absorption and conduction of water and mineral elements. Loss of root connection affects health and stability of tree and safety of people and property. Notify ENGINEER of such root cut.

C. Existing Surfaces:

1. Protect adjacent surfaces including concrete walls, planters, carriage walks, driveway approaches, rock walls, rock gardens, concrete steps, sidewalks, and curb cut assemblies. Replace damaged facilities at no additional cost to OWNER.

2. Use rubber cleats or Pavement pads when operating backhoes, outriggers, track equipment, or any other equipment on or crossing paved surfaces.

3. Restore paved surfaces that are damaged by removal operations at no additional cost to the OWNER. Match the existing Pavement surface.

D. Environment:

1. Control dust, Section 01 57 00 Temporary Controls.

2. Implement silica dust controls on cutting equipment according to Table 1 of the OSHA Silica Dust standard 29 CFR 1926.1153.

3. Protect plant and animal habitat.

4. Protect migratory birds. Removal of trees and shrubs during bird nesting season will require a nest survey by a qualified biologist.

5. Protect water resources. Control stormwater runoffs from disturbed areas.

6. Follow federal, state and local regulations.

E. Repair or replace any damage at no additional cost to OWNER.

3.3 REMOVE PORTLAND CEMENT CONCRETE PAVEMENT

A. See APWA Plan 256 requirements.

B. Cutting:

1. DO NOT use machine mounted impact hammers.

2. Make concrete cuts straight, vertical, true, full-depth.

3. Cut along perimeter of panel to be removed. Where edge of existing surface is cracked, broken, or deteriorated, make the cut so the defective surface can be removed.

4. Cut along any edge that is damaged during construction, including cavities underneath caused by construction or concrete removal.

C. Removal:

1. Remove concrete to the nearest expansion joint or vertical saw cut.

2. Remove panels without damaging remaining panels.

3. Remove all bonding inhibitors.

D. Dispose of removed concrete in compliance with local, state, and federal regulations.

3.4 REMOVE BITUMINOUS CONCRETE PAVEMENT

A. Cutting:

1. Use any method that produces a true, vertical, full-depth cut.

2. When bituminous pavement overlays Portland cement concrete Pavement, DO NOT use machine mounted impact hammers.

3. If an edge of an existing surface is cracked, broken, or deteriorated, make the cut so the defective surface can be removed.

4. Re-cut along any edge that is damaged during construction, and where cavities underneath pavement are caused by construction.

B. Remove Pavement: Remove pavement without damaging remaining.

C. Dispose of removed bituminous concrete, in compliance with local, state, and federal regulations.

3.5 REMOVE CONCRETE FLAT WORK

A. Saw cut flat work at weakened plane joints. Saw cut full depth.

B. Where edge of existing surface is cracked, broken, or deteriorated, make the cut so the defective surface can be removed.

C. Saw along any edge that is damaged during construction, including cavities underneath caused by construction.

D. If flat work that is not scheduled for removal is damaged, remove and replace the flat work at no additional cost to OWNER.

3.6 CLEANING

A. Remove all debris and dust. Clean surrounding rails, sidewalks, Driveways, Driveway approaches, landscaping, concrete flat work, and other objects in vicinity of work.

3.7 HAZARDOUS MATERIALS IDENTIFICATION AND HANDLING

A. Conduct survey to identify hazardous materials that might be encountered during pavement removal. This may include, but not limited to lead-based paint, petroleum-based products, or contaminated soil underneath the pavement.

3.8 SITE RESTORATION

A. Following pavement removal, restore the site through grading, erosion control measures, and revegetation as required.

3.9 PAVEMENT REMOVAL WASTE MANAGEMENT

A. Handle, recycle, and/or dispose of pavement removal waste in accordance with local, state, and federal regulations.

3.10 QUALITY CONTROL

A. Maintain strict quality control throughout the pavement removal process, ensuring that cuts are clean and precise, and damage to adjacent structures and surfaces is minimized.

B. Inspect the work area and take corrective action as needed.

3.11 VIBRATION MONITORING

A. Monitor vibrations during pavement removal operations to ensure that adjacent structures are not damaged or adversely affected.

B. If vibration levels exceed established limits, adjust or modify pavement removal methods as needed.

3.12 COORDINATION WITH OTHER TRADES

A. Coordinate pavement removal activities with other trades and stakeholders, such as utility companies, traffic control personnel, and nearby property owners, to minimize disruption and ensure a smooth workflow.

END OF SECTION

SECTION 02 41 15

CURB AND TRIP HAZARD REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Saw cut and remove a curb.
2. Remove a trip hazard by saw cutting, grinding, or jacking.

1.2 REFERENCES

A. APWA (Utah) Standards:

1. Plan 222 Saw cut driveway approach.
2. Plan 235 Corner curb cut assembly.
3. Plan 236 Tangent curb cut assembly.
4. Plan 237 Island and median.

B. Applicable federal, state, and local safety regulations.

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26 Traffic Control.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 SITE CONDITIONS

A. Control dust, Section 01 57 00 Temporary Controls.

B. Ensure that operations do not interfere with pedestrian or vehicular traffic flow, as per traffic control plan.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 PROTECTION

A. Implement traffic control plan requirements, Section 01 55 26.

B. Do not damage abutting surfaces that are not scheduled for cutting or removal.

C. Protect plant and animal habitat. Follow federal, state or local protection requirements.

3.2 CURB REMOVAL FOR NEW DRIVEWAY APPROACH

A. Remove curb as shown in APWA Plan 222.

B. At the Apron: Saw off curb so surface of curb cut matches slope of apron. Do not provide a lip at flow-line unless indicated elsewhere.

C. At the Curb Flare: Saw off curb perpendicular to the back of curb:

1. If the flare is in a pedestrian walking area, limit the curb cut slope (parallel to the flow-line) to 10 percent (1:10) maximum.

2. If the flare is NOT in a pedestrian walking area, make the length of the curb cut slope (parallel to the flow-line) three (3) feet minimum.

D. Remove blade marks on sawed surfaces by grinding.

E. Verify that the curb removal does not affect the stability or integrity of the surrounding infrastructure or nearby signage.

1. CONTRACTOR to repair/replace any damaged surroundings that are out of scope.

3.3 CURB REMOVAL FOR NEW CURB CUT ASSEMBLY

A. For assembly types see APWA Plans 235, 236, and 237.

B. Curb Ramp or Blended Transition: Saw off curb to match the surface slope of the Curb Ramp or Blended Transition.

C. Curb Flare: Saw off the curb perpendicular to the back of curb:

1. If the flare is in a pedestrian walking area, limit the curb cut slope (parallel to the flow-line) to 10 percent (1:10) maximum.

2. If the flare is NOT in a pedestrian walking area, typical horizontal length of the curb cut slope is two (2) feet.

D. Remove blade marks on sawed surfaces by grinding.

3.4 TRIP HAZARD REMOVAL

A. DO NOT cut or grind structural elements such as bridge decks, catch basins, manholes, concrete borders, culverts, etc. ENGINEER must determine other means of trip hazard removal.

B. Remove trip hazards greater than 1/4 inch high but less than 1 1/2 inches high. ENGINEER must determine acceptable means for removing trip hazards higher than 1 1/2 inches.

C. Make saw cut slopes, grinding slopes, and milled slopes not steeper than 10 percent (1:10) measured in direction of pedestrian travel. Grind sawed or milled surfaces to remove blade marks or to make smooth.

D. If flat work is jacked (Section 32 01 29), jack until displacement differential is less than 1/4 inch. Repair adjacent flat work elevations if adversely moved out of place because of the jacking process. Repair damaged form strip irrigation system or vegetation if growth is adversely affected.

3.5 CLEANING AND REPAIR

A. Remove debris and dust from work site. Ensure that all materials are disposed of properly, in compliance with local and federal regulations.

B. Clean surrounding rails, concrete flat work, Driveway aprons, landscaping and other objects in vicinity of work.

C. Repair damage at no additional cost to OWNER.

D. Conduct a final site inspection to ensure full compliance with the cleaning and repair requirements. Document any remaining issues and schedule necessary follow-up actions.

E. Provide a post-operation report that includes a detailed account of the work done, issues encountered, and the resolution of those issues. This report should be submitted to the OWNER for record-keeping and future reference.

END OF SECTION

SECTION 02 41 19

SELECTIVE BUILDING DEMOLITION-ALTERATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Selective demolition of building elements for alteration purposes.

1.2 REFERENCES

A. Related Requirements:

1. Section 01 11 00 “Summary”: Limitations on CONTRACTOR's use of site and premises.

2. Section 01 11 00 “Summary”: Description of items to be salvaged or removed for re-use by CONTRACTOR.

3. Section 01 50 00 “Temporary Facilities and Controls”: Site fences, security, protective barriers, and waste removal.

4. Section 01 60 00 “Product Requirements”: Handling and storage of items.

5. Section 01 70 00 “Closeout Procedures”: Project conditions; protection of benchmarks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

6. Section 31 11 00 “Site Clearing”: Vegetation and existing debris removal.

7. Section 31 23 16 “Excavation”: Topsoil removal.

1.3 SUBMITTALS

A. Not Applicable.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain OWNER’s property unless indicated otherwise by ENGINEER.

B. Remove and Salvage: Items indicated to be removed and salvaged remain OWNER's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to OWNER's designated storage area.

C. Remove and Reinstall: Remove items indicated. Clean, service, and otherwise prepare them for re- use. Store and protect against damage. Reinstall them in locations indicated.

1. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

2. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

D. Existing to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by ENGINEER, items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.

1.7 PROJECT CLOSEOUT

A. Record removals on Drawings. Submit Record Documents, Section 01 78 39 Project Record Documents.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

A. Survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition.

B. Obtain project environmental impact review.

C. All furnishing environmental, equipment, etc. that are to be removed from site shall remain property of OWNER. ENGINEER shall determine appropriate action for property in question.

D. If OWNER occupies portions of building immediately adjacent to selective demolition area, conduct selective demolition so OWNER's operations will not be disrupted.

E. Provide not less than 72 hours notice to OWNER of activities that will affect OWNER's operations. Also submit 72 hour notifications to ENGINEER.

F. OWNER assumes no responsibility for actual condition of buildings to be selectively demolished.

3.2 DEMOLITION

A. Comply with Laws and Regulations before, during, and after selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Photograph or videotape existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by selective demolition operations.

C. Storage or sale of removed items or materials on site will not be permitted.

D. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.

1. Verify that construction and utility arrangements are as indicated.

2. Report discrepancies to ENGINEER before disturbing existing installation.

3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.

E. Remove existing work as indicated and as required to accomplish new work.

1. Remove items indicated on drawings.

2. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

F. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, Telecommunications, and [ ]): Remove existing systems and equipment as indicated.

1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.

2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.

3. Verify that abandoned services serve only abandoned facilities before removal.

4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.

G. Protect existing work to remain.

1. Prevent movement of structure; provide shoring and bracing if necessary.

2. Perform cutting to accomplish removals neatly and as specified for cutting new work.

3. Evaluate any changes or damages to existing adjacent structures and report to the respective owner/authority prior to commencing any repairs.

4. Repair adjacent construction and finishes damaged during removal work.

5. Patch as specified for patching new work.

3.3 SITE RESTORATION

A. Following demolition, restore the site through grading, erosion control measures, and revegetation as required.

3.4 DEMOLITION WASTE MANAGEMENT

A. Handle, recycle, and dispose of demolition waste in accordance with local, state, and federal regulations.

END OF SECTION

SECTION 02 60 00

CONTAMINATED SITE MATERIAL REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Comply with provisions of UTA "Materials Management Procedures" and/or the project-specific contaminated material management plan.

B. Execute the removal, handling, transportation, and disposal of contaminated materials in a manner that ensures the safety of workers and the public, prevents further contamination of the environment, and complies with federal, state, and local regulations.

C. Maintain thorough documentation of all contaminated materials, their sources, and disposal methods.

1.2 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

2. Relevant health and safety standards and guidelines for handling and disposal of contaminated materials.

1.3 SUBMITTALS

A. Not Applicable.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 – PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. Utilize equipment and materials that are suitable for the task, comply with safety standards, and minimize the potential for spreading contamination.

PART 3 - EXECUTION

3.1 PROCEDURES

A. Carry out the contaminated site material removal in accordance with the Materials Management Procedures.

B. Regularly monitor and adjust operations as needed to ensure safety and efficacy.

C. Document the removal process, including the volume of material removed, the methods used, any issues encountered, and the steps taken to resolve them.

3.2 SAFETY MEASURES

A. Implement safety measures to protect workers and the public from exposure to contaminated materials.

B. Train workers on safe handling and disposal procedures for contaminated materials.

C. Provide appropriate personal protective equipment (PPE) to all workers involved in the removal process.

3.3 POST-REMOVAL ACTIONS

A. Carry out thorough site cleanup after the removal of contaminated materials.

B. Validate that the site is free from contamination post-removal, using appropriate testing methods.

C. Document all post-removal actions and provide a comprehensive report to the relevant stakeholders.

END OF SECTION

Division 03 – Concrete

SECTION 03 11 00

CONCRETE FORMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formwork for cast-in-place concrete.
2. Openings in formwork for other affected work.
3. Form accessories such as snap ties, bracing, etc.
4. Stripping formwork.

1.2 REFERENCES

A. ACI Standards.

1. 301 Specifications for Concrete Construction
2. 347 Recommended Practice for Concrete Formwork
3. SP-4 Formwork for Concrete

1.3 SUBMITTALS

A. Shop Drawings: Fabrication and erection drawings of forms for specific finished concrete surfaces, as indicated. Show general construction of forms, jointing, special joints or reveals, location and pattern of form tie placement, and other items affecting exposed concrete visibility.

B. Form Release Agent: Where concrete surfaces are scheduled to receive special finishes or applied coverings which may be affected by agent submit manufacturer's instructions for use of agent.

1.4 QUALITY ASSURANCE

A. Designer's Qualifications: Structural design professional who complies with Utah licensing law, has experience in concrete formwork, and is acceptable to the authority having jurisdiction.

B. Design Forms:

1. True to line and grade, with sufficient strength to maintain finished tolerances indicated in Section 03 35 00, to support loads, pressures, and allowable stresses as outlined in ACI 301 and 347 and for design considerations such as wind loads, allowable stresses, and other applicable requirements of local Laws and Regulations.

2. To permit easy removal.

3. For required finishes.

C. Design, engineering, and construction of formwork is CONTRACTOR's responsibility.

1.5 ACCEPTANCE

A. Secure ENGINEER's inspection of form layout for concrete flat work.

1.6 DEFINITIONS

A. Shoring: The activity to support formwork.

B. Reshoring: The activity to reduce the amount of formwork supporting concrete elements. As concrete sets and strength increases, less need for formwork occurs gradually until concrete becomes free standing.

1.7 JOB CONDITIONS

A. For reference purposes, establish and maintain sufficient control points and benchmarks to check tolerances. Maintain in an undisturbed condition and until final completion and acceptance of Work.

B. Regardless of tolerances specified, allow no portion of Work to extend beyond legal boundaries.

1.8 FIELD SAMPLES

A. Prepare field Samples and submit per Section 01 33 00 Submittal Procedures.

B. Construct and erect sample formwork panel for architectural concrete surfaces receiving special treatment or finish as a result of formwork. Formwork to include vertical and horizontal form joints and typical rustication joints when required.

C. Size panel to indicate special treatment or finish required, including form release agent.

D. Remove formwork after casting concrete.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Faced with material which will produce smooth and uniform texture on concrete, unless indicated otherwise.

B. Arrange facing material orderly and symmetrical, keeping number of seams to a minimum.

C. Do not use material with raised grain, patches, or other defects which will impair texture of concrete surface.

2.2 FORMWORK ACCESSORIES

A. Form Ties:

1. Use ties constructed so end fasteners can be removed without spalling concrete faces. For water retaining structures, suitable ties to be used subject to approval by ENGINEER.

2. After end fasteners of ties have been removed, embedded portion of ties are to terminate not less than two (2) times the diameter or thickness of the fasteners from formed faces of concrete, but in no case greater than 3/4 inch.

3. When formed face on concrete is not exposed, form ties may be cut off and the exposed metal portion of the tie shall be sealed to prevent corrosion or possible staining of the surface, except where stainless steel form ties or fiberglass ties are used. Use ties with 3/4 inch diameter cones on both ends or an approved equal for water retaining structures.

B. Premolded Expansion Joint Filler: F-1 sheet, Section 32 13 73 Concrete Paving Joint Sealants unless indicated elsewhere.

C. Form Release Agent: Colorless material which will not stain or discolor concrete, absorb moisture, impair natural bonding or color characteristics of concrete. To prevent contamination, agents used on potable water structures are subject to review by ENGINEER before use.

D. Fillets for Chamfered Corners: Wood strips 1 inch x 1 inch size, maximum length possible.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify lines, levels, and measurements before proceeding with formwork.

3.2 FORM CONSTRUCTION

A. Make forms sufficiently tight to prevent loss of concrete and mortar.

B. Unless indicated otherwise, place ¾” x ¾” reveal/chamfer strips in corners of forms to produce beveled edges on permanently exposed exterior corners. Use rigid plastic or wood strip type. Use maximum possible lengths. Mill wood strips from straight-grained lumber and surface all sides.

C. To maintain specified finish tolerances, camber formwork to compensate for anticipated deflections.

D. Provide positive means of adjustment using wedges, jacks, Shores, and struts to take up all settlement during concrete placing operation.

E. Provide temporary ports in formwork to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

F. At construction joints, overlap forms over hardened concrete at least six (6) inches. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain true surface.

G. Construct wood forms for wall openings to facilitate loosening or counteract swelling.

H. Fasten wedges used for final adjustment of forms before concrete placement in position after final check.

I. Anchor formwork to Shores, supporting surfaces or members to prevent upward or lateral movement and deflection of any part of formwork system during concrete placement.

J. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing.

K. Position expansion joint material and other embedded items accurately and support to prevent displacement.

L. To prevent entry of concrete, fill voids in sleeves, inserts, and anchor slots temporarily with readily removable material.

M. For architectural concrete, limit deflection of facing materials between studs as well as deflection of studs and walers to 0.0025 times span.

N. For underground concrete work, do not use soil walls for forming unless authorized by ENGINEER.

3.3 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings for elements embedded in or passing through concrete.

B. Coordinate work of other sections for the forming and setting of openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

C. Install accessories per manufacturer's instructions. Ensure items are not disturbed during concrete placement.

3.4 FORM FINISHES

A. Use forms with smooth rubbed, scrubbed, sand floated finishes that meet ACI 347 unless indicated otherwise.

B. For As-cast Finishes:

1. Install form panels in orderly arrangement with joints planned in approved relation to building elements.

2. Where panel joints are recessed or otherwise emphasized, locate form ties within joints, not within panel areas.

3. Where an as-cast finish is required, no grouting will be permitted in the finishing operation.

C. Textured Finishes: As indicated.

3.5 APPLICATION OF FORM RELEASE AGENT

A. Apply form release agent on formwork per manufacturer's instructions. Apply before placing reinforcing steel, anchoring devices, and embedded items.

3.6 FORM REMOVAL

A. Do not pry against face of concrete. Use only wooden wedges.

B. When repair of surface defects or finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations.

C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging. Perform needed repairs or treatment required on such sloping surfaces at once, followed by specified curing.

D. Loosen wood forms for wall openings as soon as it can be accomplished without damage to concrete.

E. Formwork for columns, walls, sides of beams, and other members not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

F. Where no Reshoring is planned, leave forms and Shoring used to support weight of concrete in beams, slabs, and other concrete members in place until concrete has attained its specified strength.

G. Where Reshoring is planned, supporting formwork may be removed when concrete has reached 70 percent of specified strength, provided Reshoring is installed immediately.

H. When Shores and other vertical supports are so arranged that non-load carrying, form-facing material may be removed without loosening or disturbing Shores and supports, facing material may be removed at an earlier age.

3.7 RESHORING

A. When Reshoring is permitted or required, plan operations in advance and obtain approval.

B. During Reshoring do not subject concrete in beam, slab, column, or any other structural member to combined dead and construction loads and live loads in excess of loads permitted for developed concrete strength at time of Reshoring.

C. Place Reshores as soon as practical after stripping operations are complete, but in no case later than end of working day on which stripping occurs.

D. Tighten Reshores to carry required loads without over-stressing.

E. Leave Reshores in place until the concrete being supported has reached its specified strength.

F. For floors supporting Shores under newly placed concrete, level original supporting Shore or Reshore:

1. Reshoring system shall have a capacity to resist anticipated loads in all cases equal to at least 1/2 the capacity of the Shoring system.

2. Unless otherwise specified locate Reshores directly under a Shore.

3. In multistory buildings, extend Reshoring through a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads in such a manner that design loads of floors and supporting Shores are not exceeded.

G. Design, engineering, and construction of Shoring and Reshoring is the responsibility of the CONTRACTOR.

3.8 REMOVAL STRENGTH

A. When removal of formwork or Reshoring is based on concrete reaching a specified strength, it shall be assumed that concrete has reached this strength when either of the following conditions has been met:

1. When test cylinders, field cured along with the concrete they represent, have reached the specified strength.

2. When concrete has been cured per Section 03 39 00 Concrete Curing for the same length of time as the site-cured cylinders that reached specified strength. Determine the length of time the concrete has been cured in the structure by cumulative number of days or fractions thereof, not necessarily consecutive, during which the air temperature is above 50 deg F and concrete has been damp or sealed from evaporation and loss of moisture.

3.9 REUSE OF FORMS

A. Do not reuse forms if there is any evidence of surface wear or defect which would impair quality of concrete surface.

B. Thoroughly clean and properly coat forms before reuse.

3.10 FIELD QUALITY CONTROL

A. Before commencing a pour, verify connections, form alignment, ties, inserts and Shoring are placed and secure.

B. Observe formwork continuously while concrete is being placed to verify that the forms are plumb and there are no deviations from desired elevation, alignment, or camber.

C. If during construction any weakness develops and false-work shows undue settlement or discoloration, stop work, remove affected construction if permanently damaged, and strengthen false-work.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Reinforcing steel bars, dowel bars, wire fabric or rod mats for cast-in-place concrete.

2. Support chairs, bolsters, bar supports, and spacers for supporting reinforcement.

1.2 REFERENCES

A. AASHTO Standards:

1. M254 Corrosion Resistant Coated Dowel Bars.

2. M336 Steel Wire and Welded Wire.

B. ACI Standards:

1. 301 Structural Concrete for Buildings.

2. 315 Concrete Reinforcement.

3. 355.4 Qualification of Post-Installed Adhesive Anchors in Concrete.

C. ASTM Standards:

1. A82 Steel Wire, Plain, for Concrete Reinforcement.

2. A185 Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement.

3. A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

4. A706 Low-Alloy Steel Deformed Bars for Concrete Reinforcement.

5. A767 Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

6. ASTM A775 Standard Specification for Epoxy Coated Steel Reinforcing.

7. C1116 Fiber-Reinforced Concrete and Shotcrete.

8. D3963 Epoxy-Coated Reinforcing Steel.

D. AWS Standards:

1. D1.1 Structural Welding Code Steel.

2. D1.4 Structural Welding Code Reinforcing Steel.

E. CRSI Standards:

1. Manual of Standard Practice.

1.3 SUBMITTALS

A. Manufacturer's Certificate: Submit mill test certificates of supplied concrete reinforcement, indicating physical and chemical analysis.

B. Welder's certification.

C. Shop Drawings:

1. Indicate sizes, spacings, locations, and quantities of reinforcing steel, wire fabric, bending and cutting schedules, splicing, stirrup spacing, supporting, and spacing devices.

2. When required, prepare Shop Drawings by an engineer who complies with Utah licensing law and is acceptable to agency having jurisdiction.

1.4 QUALITY ASSURANCE

A. Perform concrete reinforcement work per CRSI Manual of Standard Practice.

B. Comply with ACI 301.

C. Welders: Certified to comply with AWS D1.1 or AWS D1.4 as applicable.

1.5 ACCEPTANCE

A. Unless specified otherwise, chairs for supporting reinforcement in flat slabs are spaced as follows:

1. Three (3) feet maximum for No. 5 and smaller bars.

2. Five (5) feet maximum for bars larger than No. 5.

B. Dowels are placed on dowel baskets and properly aligned.

C. Epoxy and galvanized coatings shall not be chipped or cut. Ends of cut bars are epoxy coated or galvanize painted before placement.

D. Minimum covering over reinforcement is as specified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fiber Reinforcement: Glass, ASTM C1116.

B. Reinforcement:

1. Grade 60 ksi deformed steel bars, ASTM A615 and supplementary requirements S1 or ASTM A706 for welding. Welded wire fabric. Plain steel type, ASTM A185 in flat sheets or coiled rolls. Dimensions of the mesh 4”x 4” or as indicated.

C. Stirrups: Steel, ASTM A82.

D. Dowel Bars for Expansion Joints: Grade 60 ksi smooth steel bar, ASTM A615.

1. Galvanized or epoxy coated in roadway Pavements.

2. Provide plastic cap to permit longitudinal movement of dowel bar within concrete section equal to joint width plus 1/4 inch.

3. For load transfer joints, paint bars with 1 coat of paint conforming to AASHTO M254 and coat 1/2 with grease.

E. Coatings for Corrosion Protection:

1. Epoxy coat, ASTM D3963 and ASTM A775.

2. Galvanized, ASTM A767.

2.2 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage annealed type or an acceptable patented system.

B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during installation and placement of concrete.

2.3 FABRICATION

A. Fabricate reinforcement, ACI 315 providing for concrete cover.

B. Locate reinforcing splices not indicated on Drawings at points of minimum stress. Indicate location of splices on Shop Drawings.

C. Weld reinforcing bars; with AWS D1.4.

PART 3 - EXECUTION

3.1 PLACING

A. All reinforcement to be free of loose mill scale, loose or thick rust, dirt, paint, oil or grease.

B. Protect the reinforcement and the coating during handling and storage.

C. Use systems with padded contact areas when handling epoxy coated bars.

1. Pad all bundling bands for epoxy coated bars.

2. Lift all bundles with strong-back, multiple supports, or a platform bridge.

3. Do not drag or drop bars.

D. Place all reinforcement in the exact position indicated. With tie wire, tie bars together at all intersections except where spacing is less than 12 inches in each direction, in which case tie alternate intersections.

E. Maintain the distance from vertical forms and between layers of reinforcement by means of prefabricated chairs, ties, hangers, or other approved devices. Placing and fastening of reinforcement in each section of the Work must be approved before concrete is placed.

F. Overlap sheets of metal mesh one square plus six (6) inches to maintain a uniform strength. Securely fasten at the ends, edges, and supports to maintain clearances.

G. Flat Slab Work:

1. Support reinforcing steel of formed flat slabs with plastic chairs, precast concrete blocks or other non-oxidizing slab bolsters.

2. Size chairs or bolsters to position the steel in the exact location indicated.

3. Space chairs and bolsters not more than five (5) feet on centers in each direction.

4. Coat metal supports in contact with forms to prevent rust.

5. Tie down deck steel to beams or forms at regular intervals of not more than five (5) feet on centers along the beams or forms to prevent movement of steel during concrete placement.

3.2 SPLICING

A. Furnish all reinforcement in the full lengths indicated unless otherwise permitted. Splicing of bars, except where indicated is not permitted without ENGINEER’s knowledge. Stagger splices where possible.

B. Unless indicated otherwise, overlap reinforcing bars a minimum of 30 diameters to make the splice. In lapped splices, place the bars and wire to maintain the minimum distance for clear spacing to the surface of the concrete.

C. Do not use lap splices on bars greater than No. 11 diameter unless approved.

D. Weld reinforcing steel only if indicated or if authorized in writing. Weld in conformance to AWS D1.4.

E. Do not bend reinforcement after embedding in hardened concrete.

F. Do not permit reinforcement or other embedded metal items bonded to the concrete, to extend continuously through any expansion joint, except dowels in floors bonded on only one side of joints.

3.3 PLACING EMBEDDED ITEMS

A. Place all sleeves, inserts, anchors, and embedded items before concrete placement. Temporarily fill voids in embedded items to prevent entry of concrete.

B. Give all trades whose work is related to the concrete section (Section 03 30 00) ample notice and opportunity to introduce or furnish embedded items before concrete placement.

END OF SECTION

SECTION 03 30 00

CAST IN PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material requirements for Cast-in-Place concrete.

1.2 REFERENCES

A. **ACI Standards**:

1. 211.1 Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
2. 211.2 Selecting Proportions for Structural Lightweight Concrete.
3. 211.3 Standard Practice for Selecting Proportions for No-Slump Concrete.
4. 214 Evaluation of Strength Test Results of Concrete.
5. 301 Specifications for Structural Concrete for Buildings.
6. 305 Hot Weather Concreting.
7. 306 Cold Weather Concreting.
8. 318 Building Code Requirements for Reinforced Concrete.

B. **ASTM Standards**:

1. C33 Concrete Aggregates.
2. C39 Compressive Strength of Cylindrical Concrete Specimens.
3. C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
4. C94 Ready-Mixed Concrete.
5. C117 Material Finer than 75µ (No. 200) Sieve in Mineral Aggregates by Washing.
6. C123 Lightweight Particles in Aggregate.
7. C138 Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
8. C142 Clay lumps and Friable Particles in Aggregates.
9. C143 Slump of Hydraulic-Cement Concrete.

10. C150 Portland Cement.
11. C172 Sampling Freshly Mixed Concrete.
12. C227 Potential Reactivity of Cement-Aggregate Combinations (Mortar Bar Method).
13. C231 Air Content of Freshly Mixed Concrete by the Pressure Method.
14. C260 Air-Entraining Admixtures for Concrete.
15. C289 Potential Reactivity of Aggregates (Chemical Method).
16. C295 Petrographic Examination of Aggregates for Concrete.
17. C441 Effectiveness of Mineral Admixtures or Ground Blast- Furnace Slag in Preventing Excessive Expansion of Concrete Due to The Alkali-Silica Reaction.
18. C494 Chemical Admixtures for Concrete.
19. C535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
20. C595 Blended Hydraulic Cements.
21. C618 Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
22. C1064 Temperature of Freshly Mixed Portland Cement Concrete.
23. C1077 Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Laboratory Evaluation.
24. C1116 Fiber-Reinforced Concrete and Shot Crete.
25. C1157 Blended Hydraulic Cement.
26. C1240 Use of Silica Fume as a Mineral Admixture in Hydraulic Cement Concrete, Mortar, and Grout.
27. C1260 Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
28. C1293 Concrete Aggregates by Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
29. C1567 Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
30. C1602 Mixing Water Used in The Production of Hydraulic Cement Concrete.

31. C1609 Flexural Performance of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading).

32. STP 15-C Manual on Quality Control of Materials.

1.3 SUBMITTALS

A. Quality Assurance:

1. Independent Laboratory: Submit names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM and ACI standards.

2. Mixing Equipment: Submit certification of plant equipment.

B. Mix Design: Allow ENGINEER 10 days to evaluate the submittal. Provide the following information.

1. Date of mix design. If older than 180 days from date of submission recertify mix design.

2. Physical properties of the aggregate (this section article 2.3). Test results shall not be older than 365 days from the date of submission. The information is for suitability of source and not for project control. A new report will be required if aggregate source is changed.

3. Identify whether mix is for hot, cold, or normal weather placement.

4. Cement source, type, and chemical composition.

5. Aggregate soundness and potential reactivity.

   a. Test results demonstrating the ability of the combinations of cementitious materials and aggregates to control the reactivity when using potentially reactive aggregates in a mix design.

6. Average Strength (f_{cr}), per quality control chart.

7. Target and allowable range of slump and air content.

8. Water cement ratio.

9. Proportions of materials in the mix.

10. Unit weight.

11. Analysis of water if water is not potable.

12. Mortar bar or prism test results if a pozzolan is included in the mix.

13. Flexural strength test results when mix uses synthetic fiber reinforcement.

14. Technical data sheets for additives to be used at the plant and at the job site. Certify additives are compatible with each other.

C. Pre-approved Mix Design: Submit name and address of Supplier and Suppliers mix design number if available.

D. Before Changing Mix Design: Submit a new design and allow ENGINEER 10 days to evaluate the changes.

E. Hot and/or Cold Weather Plan: Include in all mix design submittals both a hot and a cold weather plan for concreting in conformance with ACI requirements. At a minimum include:

1. Detailed procedures for protection from adverse weather conditions during: placement, curing, and temperature monitoring of concrete during cold and hot weather.

2. Procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

3. Refer to Section 03 30 10 Concrete Placement, Article 3.4 for requirements.

1.4 QUALITY ASSURANCE

A. General:

1. Use a laboratory that follows and complies with ASTM C1077.

2. Reject concrete that does not meet requirements of this section.

3. If requested, submit a quality control and testing report describing source and field quality assurance activities performed by CONTRACTOR and Suppliers.

B. At Source:

1. Do not change material sources, type of cement, air-entraining agent, water reducing agent, other admixtures except as allowed by mix design.

2. Store bagged and bulk cement in weatherproof enclosures. Exclude moisture and contaminants.

3. Prevent segregation and contamination of aggregate stockpiles.

4. Avoid contamination, evaporation, or damage to admixtures. Protect liquid admixtures from freezing.

C. At Site: Use of admixtures will not relax hot or cold weather placement requirements.

1.5 ACCEPTANCE

A. Materials:

1. Aggregate Source:

a. Verify suitability of aggregate source.

b. Verify aggregate gradation.

c. Verify percent of combined aggregate passing No. 200 sieve.

2. At the Site:

a. Verify mix identification, batch time, slump, air content, and temperature.

b. Verify drum rotation is less than 300 revolutions.

3. At the Laboratory: Verify strength in 28 days.

B. Defective Material: Popouts, scaling, etc.

1. Price adjustment, Section 01 29 00 Payment Procedures and Section 03 30 10 Concrete Placement.

2. Dispute resolution, Section 01 35 10.

PART 2 - PRODUCTS

2.1 CEMENT

A. General:

1. Do not use air entraining cement.

2. Do not use cement containing lumps or is partially set.

3. Do not mix cement originating from different sources.

B. Standard Set Cement:

1. ASTM C150 Type II or Type V, low alkali.

C. Blended Hydraulic Cement: The following are cement equivalencies when substituting blended cement for a Portland cement.

Table 1 – Cement Equivalencies

Portland Cement	Blended Cement	
ASTM C150	**ASTM C595**	**ASTM C1157**
Type I	IP, IL	GU
Type II	IP (MS), IL (MS)	MS
Type III	-	HE

Type IV	-	-
Type V	IL (HS)	HS

2.2 WATER

A. Clean, non-staining, non-detrimental per ASTM C1602.

B. Screen out extraneous material.

C. Do not use alkali soil water.

2.3 AGGREGATES

A. Gravel, crushed gravel, crushed stone, crushed concrete, slag, sand or combination with the following physical properties.

Table 2 – Physical Properties

		Standard	Min	Max
Coarse Aggregate				
Wear (hardness or toughness), percent (a)		(a)	--	50
Soundness (5 cycles), percent	Na_2SO_4	C88	--	12
	Mg_2SO_4	C88	--	18
Coal and lignite (SG = 2.4 min.), percent (b)		C123	0.5	1.0
Clay lumps, friable particles, chert, percent		C142	--	7
Material finer than 200 sieve, percent		C117	--	1.0
Fine Aggregate				
Soundness (5 cycles), percent	Na_2SO_4	C88	--	10
	Mg_2SO_4	C88	--	15
Fineness modulus		C33	2.3	3.1
Coal and lignite (SG = 2.4 min.), percent (b)		C123	0.5	1.0
Clay lumps, friable particles, chert, percent		C142	--	3.0
Aggregate blend (meets one of the following)				
1. Average prism length change in 12 months, percent (c)		C1293	--	0.04
2. Average mortar bar length change in 16 days, percent (c)		C1260	--	0.10
3. Petrography limits, percent				
Quartz (d)		C295	--	5.0
Chert or Chalcedon			--	3.0
Tridymite or cristobalite			--	1.0
Opal			--	0.5
Natural glass in volcanic rock			--	3

4. Historical data acceptable to ENGINEER
NOTES: 1) Wear retained on No. 8 sieve. For aggregate less than 1 1/2" use ASTM C131. For larger aggregates use ASTM C535. 2) Organic impurities producing a dark color concrete may cause rejection. 3) Prism length change and mortar bar length change based upon unmodified ASTM tests. 4) Quartz must NOT be optically strained, micro-fractured, or microcrystalline in nature.

2.4 ADDITIVES

A. Calcium Chloride: Not allowed.

B. Air Entrainment: ASTM C260. For extrusion enhancement use non- vinsal resin.

C. Set Enhancement and Water Reducing Agents: ASTM C494.

1. Type A: Water reducing.

2. Type B: Set retarding.

3. Type C: Set accelerating.

4. Type D: Water reducing and set retarding.

5. Type E: Water reducing and set accelerating.

6. Type F: High range water reducing (super plasticizer). *

7. Type G: High range water reducing and set retarding. *

* Keep the relative durability factor of water reducing additives not less than 90 and the chlorides content (as Cl^-) not exceeding 1 percent by weight of the admixtures.

D. Pozzolan:

1. Natural or fly ash per ASTM C618.

2. Silica fume per ASTM C1240.

E. Special Admixtures: Allowed if mix design submittal is accepted:

1. Lithium nitrate based solution for control of reactive aggregates.

2. Calcium nitrite based solution for corrosion protection of reinforced structures subject to chloride-induced corrosion.

3. Shrinkage reducer for controlling drying shrinkage in concrete.

4. Viscosity modifier for enhancement of self-consolidating concrete or for workability.

2.5 MIX DESIGN

A. Class: Unless specified elsewhere, as follows.

1. Above Ground: 5000 minimum.

2. At Ground Level: 4000 minimum.

3. Underground: 4000 minimum.

4. Duct bank: 3000 minimum.

B. Selection of Cement:

1. For sulfate resistance, use Type V or Type II Portland cement, or equivalent from Table 1.

2. Class F fly ash may be used as an addition to Type V Portland cement.

3. Class N natural pozzolan to be used with Type IL cement.

4. Do not use fly ash with Type IP(MS) or Type III Portland cement.

C. Selection of Aggregates:

1. Maximum Particle Size:

a. 1/5 of narrowest dimension between forms.

b. 1/3 of depth of slab.

c. 3/4 of minimum clear spacing between reinforcing bars.

2. Gradation: ASTM C33.

a. Coarse Aggregate: Choose from the following grades. Gradations are based upon percent of material passing sieve by weight.

Table 3 – Coarse Aggregate Gradation

Sieve	Grade			
	357 (2”)	467 (1.5”)	57 (1”)	67 (3/4”)
2-1/2”	100	--	--	--
2 Inch	95 - 100	100	--	--

1-1/2”	--	95 – 100	100	--
1”	35 – 20	--	95 – 100	100
3/4"	--	35 – 70	--	90 – 100
1/2"	10 – 30	--	25- 60	--
3/8”	--	10 – 30	--	20 – 55
No. 4	0 – 5	0 – 5	0 – 10	0 – 10

b. Fine Aggregate:

Table 4 – Fine Aggregate Gradation	
Sieve	**Percent Passing by Weight**
3/8”	100
No. 4	95 to 100
No. 16	45 to 80
No. 50	10 to 30
No. 100	2 to 10

c. Silts and Clays: The amount of material smaller than the No. 200 sieve in any combined gradation sample is limited to the following percentages by weight of the combined sample:

1) 1.75 percent maximum for concrete subject to abrasion.

2) 3.0 percent maximum for all other concrete.

D. Selection of Pozzolan:

1. General: If a blended aggregate passes an unmodified ASTM C1293 test, use of a pozzolan is CONTRACTOR’s choice. If aggregate does not pass ASTM C1293, select a pozzolan (or blended cement, or both) and determine the effective dosage to meet one of the following tests:

a. ASTM C1567. The expansion of a cement-pozzolan-aggregate job-mix mortar bar is less than or equal to 0.10 percent at 16 days. Do not use this test if a lithium admixture is used in the job-mix.

b. ASTM C441. The expansion of a test mixture at 56 days is less than or equal to a control mixture prepared with cement with equivalent alkalis between 0.5 and 0.6 percent.

2. Fly Ash (Class F): Allowed as a cement replacement under the following conditions:

a. Before replacement is made, use the minimum cement content in the design formula to establish the water/cement ratio.

b. Replace up to 20 percent of the cement by weight on a one (1) part fly ash to one (1) part cement basis.

c. Submit to ENGINEER a quality history of the fly ash identifying a minimum of 20 of the most current ASTM C618 analysis.

3. Natural Pozzolan (Class N): Allowed as a cement replacement if the 14 day expansion test (ASTM C1567) with job aggregates, job cement and natural pozzolan does not exceed the 14 day expansion test of job aggregates, job cement and Class F fly ash.

4. Silica Fume: Allowed as a cement replacement if replacement of hydraulic cement on a 1 part silica fume to 1 part cement does not exceed 10 percent, and water/cement ratio is established before cement is replaced with silica fume.

E. Selection of Mix Properties: Select and proportion the mix to produce appropriate strength, durability and workability. Use ACI 211.1, 211.2, or 211.3, and meet the following properties and limitations:

Table 5 – Mix Properties and Limitations

Properties		Standard	2000	3000	4000	5000
Compressive Strength (fc') at 28 days, psi, minimum		C39	2000	3000	4000	5000
Compressive Strength at 7 days, psi, (for reference only)		C39	1340	2010	2680	3350
Average Strength, psi (fcr)		214	(a)	(a)	(a)	(a)
Cement content, bags, minimum (b)		--	4.5	5.5	6.5	7.5
Water-cement ratio (by weight), maximum (c)		318	(d)	(d)	0.44	
Entrained air, percent (based upon aggregate size) (e)	2" 1-1/2" 1" 3/4"	C231	3.0 to 6.0 " " "	4.5 to 7.5 " " "	4.0 to 7.0 4.5 to 7.5 5.0 to 7.5 5.0 to 7.5	
Slump		C143	(d)	(d)	(d)	(d)

NOTES:

1) The amount by which average strength (fcr) exceeds compressive strength (fc') is based upon statistical assurance that no more than 1 test in 100 tests will fall below compressive strength (fc').
2) Unless allowed otherwise by ENGINEER.
3) Before pozzolan substitution.
4) Specific to exposure conditions and finishing need.
5) Comply with ACI 211.1 if air content is changed.
6) 1 bag of cement = 94 pounds.

1. Cold Weather: ACI 306. Unless allowed otherwise by ENGINEER, increase cement content in the mix design by 1 class between October 1 and March 1, i.e. Class 3000 becomes Class 4000, Class 4000 becomes Class 5000, etc.

2. Hot Weather: ACI 305. Reduce temperature of mix ingredients or use an admixture appropriate to job conditions when air temperature is over 75 deg F.

3. Concrete Deposited Under Water: Increase cement content one (1) class for concrete placed above water or use viscosity modifying admixture.

F. Selection of Fiber Reinforcement: The basis for determining material proportions of fiber-reinforced concrete is the Supplier's responsibility per ASTM C1116 subject to mix property requirements of this Section. Unless specified otherwise provide synthetic fibers.

2.6 SOURCE QUALITY CONTROL

A. General: Collect Samples randomly. Do not change source quality control sampling point.

B. Aggregate:

1. Soundness, ASTM C88.

2. Alkali-silica reactivity, ASTM C289, C1567, C1260, C227 and C1293.

3. Petrographically examine fine and coarse aggregate sources once every three (3) years, ASTM C295.

C. Concrete Mix: Obtain samples per ASTM C172 and run the following tests:

1. Compressive strength, ASTM C39.

2. Unit weight, ASTM C138.

3. Slump, ASTM C143.

4. Air, ASTM C231.

5. Temperature, ASTM C1064.

D. Concrete Quality Charts: Comply with ACI 214 and ACI 301. Plot new results and identify trends on quality control charts that comply in form to ASTM STP 15-C. Show the Specified Strength (f_c'), the required Average Strength (f_{cr}), and the compressive strength versus date of Sample.

E. Equipment: Certify at least every two (2) years through the services of a design professional licensed in the State of Utah, that plant equipment complies with requirements of the National Ready Mixed Concrete Association and ASTM C94.

1. Transit Trucks: Equip transit trucks with plates indicating total volume, agitating volume and mix volume.

2. Weights and Measures: Comply with regulatory requirements of State of Utah.

Table 5 – Mix Properties and Limitations

Properties		Standard	2000	3000	4000	5000
Compressive Strength (fc') at 28 days, psi, minimum		C39	2000	3000	4000	5000
Compressive Strength at 7 days, psi, (for reference only)		C39	1340	2010	2680	3350
Average Strength, psi (fcr)		214	(a)	(a)	(a)	(a)
Cement content, bags, minimum (b)		--	4.5	5.5	6.5	7.5
Water-cement ratio (by weight), maximum (c)		318	(d)	(d)	0.44	
Entrained air, percent (based upon aggregate size) (e)	2" 1-1/2" 1" 3/4"	C231	3.0 to 6.0 " " "	4.5 to 7.5 " " "	4.0 to 7.0 4.5 to 7.5 5.0 to 7.5 5.0 to 7.5	
Slump		C143	(d)	(d)	(d)	(d)

NOTES:

1) The amount by which average strength (fcr) exceeds compressive strength (fc') is based upon statistical assurance that no more than 1 test in 100 tests will fall below compressive strength (fc').
2) Unless allowed otherwise by ENGINEER.
3) Before pozzolan substitution.
4) Specific to exposure conditions and finishing need.
5) Comply with ACI 211.1 if air content is changed.
6) 1 bag of cement = 94 pounds.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Placement, Section 03 30 10 Concrete Placement.

3.2 FIELD QUALITY CONTROL

A. Mixing Plant: ASTM C94.

1. Use option C and requirements in this Section for preparing ready-mixed concrete.

2. Use scales certified by the State of Utah. Do not use volume measurement except for water and liquid admixtures.

3. Mixing time must exceed 80 seconds after adding air entrainment admixture.

B. Hand Mixing:

1. Do not hand mix batches larger than 0.5 cubic yard.

2. Hand mix only on a watertight platform.

3. Ensure all stones are thoroughly covered with mortar and mixture is of uniform color and consistency before adding water.

END OF SECTION

SECTION 03 30 05

CONCRETE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete sampling and testing requirements.

1.2 REFERENCES

A. ACI Standards:

1. 318 Building Code Requirements for Reinforced Concrete.

B. ASTM Standards:

1. C31 Making and Curing Concrete Test Specimens in the Field.
2. C39 Compressive Strength of Cylindrical Concrete Specimens.
3. C42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
4. C78 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third Point Loading).
5. C136 Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
6. C138 Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
7. C143 Slump of Portland Cement Concrete.
8. C172 Sampling Freshly Mixed Concrete.
9. C173 Air Content of Freshly Mixed Concrete by Volumetric Method.
10. C231 Air Content of Freshly Mixed Concrete by the Pressure Method.
11. C567 Unit Weight of Structural Lightweight Concrete.
12. C1064 Temperature of Freshly Mixed Portland Cement Concrete.
13. C1077 Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

1.3 SUBMITTALS

A. Concrete Supplier: If requested, submit reports and material certificates verifying concrete quality control.

B. Laboratory: Promptly submit test data results for seven (7) and 28 day breaks to Supplier, CONTRACTOR, and ENGINEER**.**

1.4 QUALITY ASSURANCE

A. Provide an ASTM C1077 compliant and ACI certified laboratory.

B. Provide Level I ACI certified field sampling technicians.

1.5 ACCEPTANCE

A. At the Laboratory:

1. Compressive strength, ASTM C31.

2. Flexure strength, ASTM C78.

B. At the Site:

1. Acceptance: Reject non-complying batches until two (2) consecutive batches are compliant then proceed in random batch testing for acceptance.

2. Sampling Protocol: ASTM C172. Unless indicated otherwise follow Table 1 sampling frequency requirements. Collect sample at discharge chute before placement, or at pumper hose after priming grout has been wasted.

Table 1 – Sampling Frequency

Rate of Placement (Cubic Yard / Day)	Temperature	Air	Slump	Strength
0 - 8	1	1	1	Determined by ENGINEER
0 – 100	1	1	1	1
Each additional 100 cu. yd. or fraction thereof	1	1	1	1

3. Testing Protocol:

a. Temperature, ASTM C1064.

b. Air content, ASTM C231 or ASTM C173 if lightweight aggregate is used.

c. Slump, ASTM C143.

d. Compressive Strength, ASTM C39 and ASTM C31.

1.6 SITE CONDITIONS

A. Assist ENGINEER: Furnish labor to assist ENGINEER in obtaining and handling acceptance Samples at site or sources.

B. Store and Cure Test Specimens: Safely store and cure concrete test specimens and acceptance test specimens for first 24 hours:

1. Follow ASTM C31 in making and curing cylinders or beams at site. Do not move the cylinders or beams for the initial 16-hour cure period. Provide initial cure temperature as follows:

a. 60 to 80 deg F for Class 4,000 or less.

b. 68 to 78 deg F for Class 5,000 or greater.

2. Equip storage device with an automatic 24-hour temperature recorder with an accuracy of plus or minus two (2) deg F.

3. Use water containing hydrated lime if water is to be in contact with cylinders or beams.

4. Ensure the device(s) can accommodate the required number of test cylinders or beams. Lack of capacity will cause the placement of concrete to cease.

5. Have the storage devices available at the point of placement at least 24 hours before placement.

6. A 24-hour test run may be required.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 PRECAST PRODUCTS

A. Obtain composite Samples from different portions of the batch.

B. Make and cure concrete test specimens for acceptance, ASTM C31.

C. Cure all precast products with water vapor or water.

D. Do not damage precast products by stripping forms or handling before the concrete reaches its specified strength.

3.2 CAST-IN-PLACE PRODUCTS

A. Obtaining Samples:

1. Batch samples, ASTM C172.

2. Core samples, ASTM C42.

B. Identify location of tests on test reports.

C. Compressive strength, ASTM C39:

1. Mold four (4) test specimens, ASTM C31.

2. For strength test perform slump, air, unit weight, and temperature test.

3. Break one (1) cylinder at seven (7) days and three (3) cylinders at 28 days.

a. For high strength concrete: break one (1) cylinder at twenty-four (24) hours, one (1) cylinder at seven (7) days, one (1) cylinder at 14 days, and one (1) cylinder at 28 days.

D. The average strength of three (3) cylinder breaks shall be considered the test result.

1. If any one cylinder in a 28 day test shows definite evidence of improper sampling, molding, handling, curing, or testing, discard the cylinder. The average strength of the remaining cylinders shall be considered the test result.

E. Tensile (flexural) strength, ASTM C78:

1. Mold four (4) test specimens, ASTM C31.

2. For strength test perform slump, air, unit weight, and temperature test.

3. Break 1 beam at seven (7) days and three (3) beams at 28 days. The average strength of the three (3) beam breaks shall be considered the test result.

4. If any one beam in a 28 day test shows definite evidence of improper sampling, molding, handling, curing, or testing, discard the beam. The average strength of the remaining beams shall be considered the test result.

F. Aggregate, ASTM C136 and C566 for fine and coarse aggregate.

G. Slump test, ASTM C143.

H. Air Test:

1. Normal weight concrete, ASTM C231.

2. Light weight concrete, ASTM C173.

I. Unit Weight:

1. Normal weight concrete, ASTM C138.

2. Light weight concrete, ASTM C567.

J. When requested, test in-place concrete by impact hammer, sonoscope, or other non-destructive device:

1. To determine relative strengths in various locations in Work.

2. To aid in evaluating concrete strength.

3. To select areas to be cored.

4. To verify quality control in the absence of control testing.

3.3 RETESTING DEFECTIVE CONCRETE STRENGTH

A. If CONTRACTOR desires to do a retest, a request to ENGINEER for retesting must be made within 35 days from time of concrete placement. No coring or retesting shall be done after 40 days have elapsed from the time of placement:

1. Choose three (3) random test locations and verify choice with ENGINEER. Obtain retest samples per ASTM C42 and test compressive strength per ASTM C39 or flexure strength per ASTM C78.

2. Establish a chain of custody for all test samples.

3. If concrete placed in the Work will be dry under service condition, air dry cores for seven (7) days before tests. Unless otherwise specified, use air temperature 60 to 80 deg F and relative humidity less than 60 percent.

4. If concrete placed in the Work will be more than superficially wet under service conditions, test cores after moisture conditioning (liquid or vapor water cure).

5. If more than 1 core shows evidence of having been damaged before testing, provide replacement cores, otherwise evaluation will be done on two (2) or more core samples.

6. Evaluate cores in accordance with ACI 318 requirements.

7. If core tests are inconclusive, or impractical to obtain, or if structural analysis does not confirm the safety of the Work, load test may be used and evaluated in accordance with ACI 318 requirements.

B. Coat sides of core hole with concrete epoxy resin adhesive. Fill core holes with non-shrink concrete mortar. Match color and texture of surrounding concrete.

C. Within 40 days from time of placement publish the chain of custody record and the results of retesting.

END OF SECTION

SECTION 03 30 10

CONCRETE PLACEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete placement for slabs on grade, slabs on fill, structural building frame, and other concrete components.

1.2 REFERENCES

A. ACI Standards:

1. 301 Structural Concrete for Buildings.
2. 305 Hot Weather Concreting.
3. 306 Cold Weather Concreting.
4. 309 Consolidation of Concrete.

B. ASTM Standards:

1. C881 Epoxy-Resin-Base Bonding Systems for Concrete.
2. C1059 Latex Agents for Bonding Fresh to Hardened Concrete.

1.3 SUBMITTALS

A. Batch Delivery Ticket: For each batch delivered to site, identify:

1. Date and Project description.
2. Producer and plant.
3. Name of contractor.
4. Serial number of ticket.
5. Mix identification number or code.
6. Truck number and time dispatched.
7. Volume of concrete.
8. Type and amount of cement.
9. Total water and water/cement ratio.
10. Water added for receiver of concrete and receiver's initials.

11. Admixture types.

12. Separate weights of fine and coarse aggregate.

13. Statement of whether batch is pre-mixed at plant or mixed in transit.

B. Record of Placed Concrete: Identify date of record, location of pour, quantity, air temperature, and CONTRACTOR's quality control test Samples taken.

C. Bonding Compound: Identify product name, type, and chemical analysis.

1.4 QUALITY ASSURANCE

A. Provide ACI certified finishers.

B. Concrete shall not be placed until formwork and accessories have been inspected and approved per Section 03 30 05 Concrete Testing requirements.

C. Remove and replace any placed concrete suffering hot or cold weather damage.

D. For control testing follow Section 03 30 05 Concrete Testing requirements.

1.5 ACCEPTANCE

A. General:

1. Price adjustment, Section 01 29 00 Payment Procedures. CONTRACTOR may request ENGINEER determine appropriate Modifications or payment adjustments to pay for Defective work.

2. Retesting by CONTRACTOR, Section 01 35 10 and Section 03 30 05 Concrete Testing.

3. Concrete work that fails to meet any of the following requirements will be considered defective. Replace Defective Work at no additional cost to OWNER.

B. Placement:

1. Reinforcing steel size, quantity, strength, position, damage, or arrangement is not as specified or does not comply with code.

2. Formwork differs from required dimensions or location in such a manner as to reduce concrete's strength or load carrying capacity or physical esthetics.

3. Workmanship likely to result in deficient strength.

C. Finishing:

1. Concrete exposed to view has defects that adversely affect appearance.

2. Slab tolerances of Section 03 35 00 Concrete Finishing are not met.

D. Protection:

1. Method of curing is not as specified.

2. Inadequate protection of concrete during early stages of hardening and strength development from:

a. temperature extremes.

b. rapid moisture loss.

3. Mechanical injury, construction fires, accidents, or premature removal of formwork likely to result in deficient strength development.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete: Section 03 30 00 Cast In Place Concrete. Class as indicated:

1. For roadway cuts, Section 33 05 25 Pavement Restoration.

B. Bonding Compound: ASTM C1059. Either polyvinyl acetate base or acrylic base latex:

1. Use type I in areas not subject to high humidity or immersion in water with minimum bond strength of 400 psi.

2. Use type II in areas subject to high humidity or immersion in water with minimum bond strength of 1250 psi.

C. Vapor Retarder: 10 mil thick clear polyethylene sheet. Type recommended for below grade application.

D. Forms: Section 03 11 00 Concrete Forming.

E. Reinforcement: Section 03 20 00 Concrete Reinforcing.

F. Coverings and Curing Compound: Section 03 39 00 Concrete Curing.

G. Shrinkage Compensating Grouts: Section 03 61 00 Cementitious Grouting.

H. Epoxy Adhesive: Section 03 61 00 Cementitious Grouting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify items to be cast into concrete are accurately placed and held securely.

B. Verify slump, air content range, mix identity, and batch time on delivery ticket matches mix design.

C. Verify slab steel mats are supported by steel chairs, precast concrete blocks, or other slab bolsters. Do not pour if absent.

3.2 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26 Traffic Control.

B. Notify ENGINEER no later than 24 hours before commencement of concrete placement.

C. Do not allow construction loads to exceed structural capacity.

D. Clean previously placed concrete. Apply bonding compound per manufacturer's instructions.

E. At locations where new concrete is dowelled to existing work, drill, remove dust, insert, and pack steel dowels with shrink compensating grout, and expansion caps where required.

3.3 DELIVERY

A. Concrete Temperature: Keep mixed concrete temperature before placement between 60 deg F. and 90 deg F.

B. Slump and Air Content: Keep within allowable ranges.

C. Transport Time:

Air Temperature	Time After Initial Batching
Less than 90 deg F	1–1/2 hours
Greater than 90 deg F	1–hour (without retarder)
Greater than 90 deg F	1–1/2 hours (with retarder)

To increase time past 1-1/2 hours, a hydration stabilizer that is acceptable to Supplier may be used.

D. Tempering:

1. Water may be added if all following conditions are met:

   a. The mix design water/cement ratio is not exceeded.

   b. The delivery ticket allows for addition of water based upon water/cement ratio.

   c. The amount of water added is accurately measured to within 1 gallon of the design addition.

   d. Water addition is followed by three (3) minutes of mixing at mixing speed before discharge.

e. Supplier and CONTRACTOR mutually agree on who is authorized to add water.

2. Do not add water after 1 cubic yard of concrete has discharged from the delivery vehicle.

E. Super-plasticizer: Comply with manufacturer's requirements. If none, then as follows:

1. If added at site, add agent using injection equipment capable of rapidly and uniformly distributing admixture to concrete. Before discharge, mix for a minimum of five (5) minutes at a drum rate not less than 12 rpm or more than 15 rpm.

2. If added at plant, do not deliver to site unless batch delivery ticket displays water/cement ratio before super-plasticizer addition.

3.4 CONCRETE PLACEMENT

A. In General: ACI 301.

1. Do not disturb reinforcement, inserts, embedded parts, and formed joints.

2. Do not break or interrupt successive pours such that cold joints occur.

3. Honeycomb or embedded debris in concrete is not acceptable.

B. Hot Weather Placement: ACI 305. If the rate of evaporation approaches 0.2 lb./ft^2/hr. precautions against plastic shrinkage cracking are necessary. (i.e. dampening Subgrade and forms; placing concrete at the lowest possible temperature; erecting windbreaks and sunshades; fog sprays; use of evaporation retardants; or rescheduling time of placement).

C. Cold Weather Placement: ACI 306. Accelerating admixture may be used in concrete work placed at ambient temperatures below 50 deg F Use of admixtures will not relax cold weather placement, curing, or protection requirements. If air temperature is forecasted to fall below 32 deg F. within 14 days of placement, proceed as follows:

1. Provide cold weather protection (cover, insulation, heat, etc.).

2. Do not use chemical "anti-freeze" additives in the concrete. (NOTE: this does not apply to normal accelerators.)

3. Do not proceed with the placement of concrete until the temperature of all contact surfaces is 35 degrees F and ambient temperature is ascending.

4. Protect the concrete from freezing until a compressive strength of at least 90 percent of design strength has been achieved, determined by either:

a. Maturity meter. Refer to AASHTO T 325, or

b. Field cured cylinders.

5. Adequately vent combustion-type heaters that produce carbon monoxide.

6. When applying external heat, maintain moist conditions to avoid excessive moisture loss from concrete.

7. When removing heat, limit drop in temperature of concrete surfaces to 20 degrees F during any 12-hour period until the surface temperature of the concrete reaches that of the atmosphere.

D. Concrete Temperature: Keep mixed concrete temperature at time of placement between 60 deg F and 90 deg F.

E. Do not disturb reinforcement, inserts, embedded parts, and formed joints.

F. Do not break or interrupt successive pours such that cold joints occur.

G. Honeycomb or embedded debris in concrete is not acceptable.

3.5 JOINTS AND JOINT SEALING

A. Steel edging and jointing tools are acceptable. Preferred are magnesium, aluminum, or wood tools.

B. Pavement joint sealing, Section 32 13 73 Concrete Paving Joint Sealants.

3.6 CONSOLIDATION

A. Keep spare vibrator available during concrete placement operations.

B. Follow ACI 309 requirements.

3.7 CURING

A. Section 03 39 00 Concrete Curing. Use a membrane forming compound unless specified otherwise.

3.8 FINISHING

A. Section 03 35 00 Concrete Finishing and as follows.

Table 1 – Finishes

Type of work	Finish
Sidewalks, garage floors, ramps, exterior concrete Pavement	Broom or belt
Exterior platforms, steps, and landings, exterior and interior pedestrian ramps, not covered by other finish materials	Non-slip
Surfaces intended to receive bonded applied cementitious applications	Scratched

Surfaces intended to receive roofing, except future floors, waterproofing membranes, and roof surfaces that are future floors or sand bed terrazzo	Floated
Floors and roof surfaces that are floors intended as walking surfaces or to receive floor coverings	Troweled
Unpainted concrete surfaces not exposed to public view	Rough as-cast form finish
Unpainted concrete surfaces exposed to public view	Smooth as-cast form finish
Concrete surfaces to receive paint or plaster	Grout cleaned finish

3.9 PROTECTION AND REPAIR

A. Protection:

1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, graffiti, and mechanical injury.

2. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

B. Repair:

1. Modify or replace concrete not conforming to required levels, lines, details, and elevations.

2. Structural analysis and additional testing may be required at no additional cost to OWNER when the strength of a structure is considered potentially deficient.

3. To patch imperfections refer to Section 03 35 00 Concrete Finishing requirements.

4. Remove graffiti and mechanical injury.

END OF SECTION

SECTION 03 35 00

CONCRETE FINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Finishing interior and exterior concrete surfaces.

1.2 REFERENCES

A. ACI Standards:

1. 303 Guide to Cast-in-Place Architectural Concrete Practice.

1.3 SUBMITTALS

A. Name, type, chemical analysis, and manufacturer's recommended rate of application for liquid chemical hardener.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PROJECT CONDITIONS

A. Protect adjacent materials and finishes from dust, dirt and other surface or physical damage during finishing operations. Provide protection as required and remove from site at completion of Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Masonry Mortar and Grout: Section 04 05 16 Masonry, Mortar, and Grout.

B. Dry Shake: Blend of metallic or mineral aggregate with Portland cement concrete in proportions recommended by manufacture.

C. Proprietary Materials: If permitted or required, proprietary compounds may be used in lieu of or in addition to foregoing blended materials. Use such compounds per manufacturer's recommendations.

D. Liquid-Chemical Hardener: Colorless, aqueous solution containing a blend of magnesium fluosilicate, zinc fluosilicate and a wetting agent. Mixture contains not less than two (2) pounds fluosilicate per gallon and does not interfere with adhesives and bonding.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas and conditions under which work of this section will be performed.

B. Correct conditions detrimental to timely and proper finishing.

C. Do not proceed until unsatisfactory conditions are corrected.

3.2 FINISHING HORIZONTAL SLABS

A. Do not apply water (i.e. sprinkle) to any surface of concrete when finishing slabs.

B. Edges and Joints: Tools may be made out of steel. Preferred is wood, aluminum or magnesium.

C. Tolerances: A permissible variation from lines, grades, or dimensions given in contract documents, shall be as below unless noted in the item specification.

1. Class A: 1 in 1000.

2. Class B: 1 in 500.

3. Class C: 1 in 250.

D. Float Finish: After concrete has been placed, consolidated, struck-off, and leveled, do not work further until ready for floating:

1. Begin floating when water sheen has disappeared, and surface has sufficient stiffness.

2. During or after first floating, check planeness of entire surface with a 10 feet long straightedge applied at two (2) or more different angles.

3. Cut down high spots and fill low spots to the required tolerance.

4. Refloat slab immediately to a uniform sandy texture.

E. Trowel Finish:

1. Do not use steel trowel or a power trowel on exterior concrete or on concrete that contains more than three (3) percent air.

2. First troweling shall produce smooth surface relatively free of defects but which may still show some trowel marks.

3. Second troweling after surface has stiffened shall make finished surface essentially free of trowel marks, uniform in texture and appearance.

4. On surfaces intended to support floor coverings, grind off defects that would show through floor covering.

F. Broom or Belt Finish: Sweep surface with brushes, rakes, tines or burlap belt before final set.

G. "Dry Shake" Finish: Give the surface a floated finish. Evenly apply approximately 2/3 of a blended unsegregated material:

1. Begin floating immediately after application of first "dry shake."

2. After material has been embedded by floating, apply remainder of blended material to surface at right angles to previous application.

3. Make second application heavier in any areas not sufficiently covered by first application.

4. Immediately follow with second floating.

5. After selected material has been embedded by second floating, complete operation with a broomed, floated, or troweled finish, as indicated.

H. Non-slip Finish: Give surface a "dry shake" application, using crushed ceramically bonded aluminum oxide particles. Apply at 25 pounds per 100 square feet.

I. Exposed Aggregate Finish: Immediately after surface of concrete has been leveled to tolerance and surface water has dissipated, spread aggregate uniformly over surface to provide complete coverage to the depth of a single stone:

1. Embed aggregate into surface by light tamping.

2. Float surface until embedded aggregate is fully coated with mortar and surface has been brought to tolerance.

3. Start exposure of aggregate after matrix has hardened sufficiently to prevent dislodgment.

4. Flow ample quantities of water, without force, over surface of concrete while matrix encasing aggregate is removed by brushing with a fine bristle brush.

5. Continue until aggregate is uniformly exposed.

6. An approved chemical retarder sprayed onto freshly floated surface may be used to extend working time.

J. Chemical-Hardener Finish: Apply liquid chemical-hardener finish to interior concrete floors where indicated. Do not apply liquid chemical hardener on floor areas scheduled to receive synthetic matrices terrazzo, setting beds for tile, terrazzo, vinyl flooring, or like items. Apply hardener after complete curing and drying of concrete surface per manufacturer's recommendations. Evenly apply each coat, and allow 24 hours for drying between coats. After final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

3.3 FINISHING FORMED SURFACES

A. General:

1. Allow concrete to cure not more than 72 hours before commencing surface finish operations, unless approved otherwise.

2. Revise the finishes as needed to secure approval.

3. Tolerances: A permissible variation from lines, grades, or dimensions given in contract documents. Abrupt irregularities shall be measured within 1 in. of the irregularity. Gradual surface irregularities shall be measured by determining the gap between concrete and near surface of a 5 ft straightedge, measured between contact points.

Class of Formed Surface			
A	**B**	**C**	**D**
1/8 in. (3mm)	1/4 in. (6mm)	1/2 in. (13 mm)	1 in. (25 mm)
Designated class of surfaces for formed concrete, unless otherwise noted: Class A: For surfaces prominently exposed to public view where appearance is of special importance. Class B: Coarse-textured, concrete-formed surfaces intended to receive plaster, stucco, or wainscoting. Class C: General standard for permanently exposed surfaces where other finishes are not specified. Class D: Minimum quality surface where roughness is not objectionable, usually applied where surfaces will be concealed.			

B. As-Cast Form Finish:

1. Rough: Patch defects, chip or rub off fins exceeding 1/4 inch height.

2. Smooth: Patch tie holes and defects and remove fins completely:

a. When surface texture is impaired and form joints misaligned, grind, bush-hammer, or correct affected concrete.

b. Slurry grout areas evidencing minor mortar Leakage to match adjacent concrete.

c. Repair major mortar Leakage as a defective area.

d. When workmanship is less than acceptable standard, provide one of rubbed finishes at no additional cost to OWNER.

C. Rubbed Finishes:

1. Smooth: Remove forms and perform necessary patching as soon after placement as possible:

a. Finish newly hardened concrete no later than 24 hours following form removal.

b. Wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced.

2. Grout Cleaned: Undertake no cleaning operations until all contiguous surfaces are completed and accessible:

a. Wet surface of concrete sufficiently to prevent absorption of water from grout.

b. Apply grout uniformly.

c. Immediately after grouting, scrub surface with cork float or stone to coat surface and fill voids.

d. While grout is still plastic, remove excess grout by working surface with rubber float or sack.

e. After surface whitens from drying, rub vigorously with clean burlap.

f. Keep damp for at least 36 hours after final rubbing.

3. Cork Floated: Remove forms within two (2) to three (3) days of placement where possible:

a. Remove ties.

b. Remove all burrs and fins.

c. Dampen wall surface.

d. Apply mortar with firm rubber float or with trowel, filling all surface voids.

e. Compress mortar into voids.

f. If mortar surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with fog sprayer.

g. Produce final texture with cork float using a swirling motion.

D. Unformed Finish:

1. After concrete is placed, strike smooth, tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces.

2. Float to texture that is reasonably consistent with formed surfaces.

3. Continue final treatment on formed surfaces uniformly across uniformed surfaces.

E. Blasted Finish:

1. Perform abrasive blasting within 24 to 72 hours after casting.

2. Coordinate with form work construction, concrete placement schedule, and formwork removal to ensure that surfaces are blasted at the same age for uniform results.

3. Reapply curing protection after blast finishing.

F. Architectural Finish, ACI 303:

1. Tooled Finish:

a. Dress thoroughly cured concrete surface with electric, air, or hand tools to uniform texture, and give a bush hammered surface texture.

b. Remove sufficient mortar to exposed coarse aggregate in relief and to fracture coarse aggregate for tooled finish.

G. Patched Finish:

1. Repair defective areas:

a. Remove honeycomb and defective concrete to sound concrete.

b. Make edges perpendicular to surface or slightly undercut.

c. Feather edges are not permitted.

d. Dampen area to be patched and at least six (6) inches surrounding it to prevent absorption of patching mortar water.

e. Prepare bonding grout.

f. Mix to consistency of thick cream.

g. Brush into surface.

2. Tie Holes: Unless indicated otherwise, after being cleaned and thoroughly dampened, fill tie hole solid with patching mortar.

3. Make patches in concrete closely match color and texture of surrounding surfaces. Determine mix formula for patching mortar by trial and obtain a good color match with concrete when both patch and concrete are cured and dry:

   a. Mix white and gray Portland cement as required to match surrounding concrete to produce grout having consistency of thick paint.

   b. Use a minimum amount of mixing water.

   c. Mix patching mortar in advance and allow to stand without frequent manipulation, without addition of water, until it has reached stiffest placeable consistency.

   d. After initial set, dress surfaces of patches manually to obtain same texture as surrounding surfaces.

4. After surface water has evaporated from patch area, brush bond coat into surface:

   a. When bond coat begins to lose water sheen, apply patching mortar.

   b. Thoroughly consolidate mortar into place and strike-off to leave patch slightly higher than surrounding surface.

   c. Leave undisturbed for at least one (1) hour before final finish.

   d. Keep patched area damp for 72 hours or apply curing compound.

   e. Do not use metal tools in finishing an exposed patch.

5. Whereas-cast finishes are indicated, total patched area may not exceed 1 in 500 of as-cast surface. This is in addition to form tie patches if ties are permitted to fall within as-cast areas.

6. In any finishing process which is intended to expose aggregate on surface, patched areas must show aggregate:

   a. Outer 1 inch of patch shall contain same aggregate as surrounding concrete.

   b. For aggregate transfer finish, patching mixture shall contain same selected colored aggregates.

   c. After curing, expose aggregates together with aggregates of adjoining surfaces by same process.

END OF SECTION

SECTION 03 39 00

CONCRETE CURING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete curing requirements.

1.2 REFERENCES

A. ACI Standards:

1. 301 Structural Concrete for Buildings.
2. 305 Hot Weather Concreting.
3. 306 Cold Weather Concreting.

B. ASTM Standards:

1. C171 Sheet Materials for Curing Concrete.
2. C1315 Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

1.3 SUBMITTALS

A. Curing agent data sheet.

B. Curing plan. Describe estimated cure quantity and procedure.

C. Manufacturer certificates, Section 01 33 00 Submittal Procedures that shows product meets performance criteria.

D. Manufacturer's recommended installation procedures which, when accepted by ENGINEER, will become the basis for accepting or rejecting installed product.

1.4 QUALITY ASSURANCE

A. Use workers knowledgeable of ACI 301, 305, 306.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PRODUCT HANDLING

A. Protect materials of this Section before, during, and after installation.

B. Protect the work and materials of other trades.

C. In the event of damage, immediately make replacements and repair at no additional cost to OWNER.

1.7 WEATHER LIMITATIONS

A. Above 75 deg F, ACI 305.

B. Below 55 deg F, ACI 306.

PART 2 PRODUCTS

2.1 COVERS

A. Water or Fog-Spray: Clean, non-staining and non-detrimental to concrete.

B. Sheet Coverings: White waterproof paper, polyethylene film, or polyethylene coated burlap sheet complying with ASTM C171.

C. Mat Coverings: Clean roll goods of cotton or burlap fabric.

D. Insulating Coverings: Non-staining curing blankets.

2.2 MEMBRANE FORMING COMPOUND

A. Material:

1. Styrene-acrylic.

2. Styrene-butadiene.

3. Alpha-methylstyrene.

B. Reference: ASTM C1315:

1. Type II Class A or B (white pigmented).

2. Type ID Class A (clear with fugitive dye).

C. Volatile Organic Compounds (VOC): Comply with local, state and federal requirements.

PART 3 EXECUTION

3.1 PREPARATION

A. *DO NOT DILUTE CURING COMPOUNDS*.

B. Do not use membrane forming curing compound on surfaces that are to receive hardeners.

C. Commence curing operation within 20 minutes after finishing.

3.2 APPLICATION – COVERS

A. Water: Apply water-fog spray or ponding.

B. Absorptive Mat: Place absorptive mat to provide coverage of concrete surfaces and edges. Lap over adjacent absorptive covers. Thoroughly saturate with water and keep continuously wet.

C. Moisture-Retaining Sheet: Place cover in widest practicable width with sides and ends lapped and sealed to prevent moisture loss. Repair any holes or tears during curing period.

D. Formed Surface Curing: Cure formed concrete surfaces, including underside of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period. If forms are removed before curing completion, applying cure film or penetrant or use methods indicated above, as applicable.

3.3 APPLICATION – MEMBRANE FORMING COMPOUND

A. Apply coating continuously and uniformly. Follow manufacturer's recommendations.

B. Protect continuity of film coatings and repair damage during cure period.

C. If forms are removed before expiration of cure period, apply coating to unprotected areas.

3.4 CONCRETE CURE TEMPERATURE

A. During cure period, eliminate thermal shock of concrete by keeping cure temperature even throughout extent and depth of concrete.

3.5 SCHEDULE

A. Concrete Exposed to Potable Water (as in Water Storage reservoirs):

1. Moisture cover curing, or

2. Acrylic cure, or

3. Styrene acrylic silane co-polymer cure.

END OF SECTION

Division 04 – Masonry

SECTION 04 05 16

MASONRY, MORTAR, AND GROUT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mortar and grout for masonry work.

1.2 REFERENCES

A. ASTM Standards:

1. C144 Aggregate for Masonry Mortar.
2. C150 Portland Cement.
3. C207 Hydrated Lime for Masonry Purposes.
4. C270 Mortar for Unit Masonry.
5. C404 Aggregates for Masonry Grout.
6. C476 Mortar and Grout for Reinforced Masonry.
7. C780 Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
8. C1019 Sampling and Testing Grout.
9. D1667 Standard Specification for Flexible Cellular Materials—Poly (Vinyl Chloride) Foam (Closed-Cell) (For Insulated Concrete Forms).

1.3 SUBMITTALS

A. Certification of Material: Submit manufacturer's mill test certificates covering materials shipped. Bags shall show contents meet specifications herein.

B. Design Mix: Indicate proportions of Portland cement, hydrated lime and sand to be used, required environmental conditions, and admixture limitations.

C. Concrete Forming Systems: Provide details of proposed concrete forming systems including type, material, and manufacturer.

1.4 QUALITY ASSURANCE

A. Follow ASTM C780 for testing mortar mix.

B. Follow ASTM C1019 for testing grout mix.

C. All concrete forms must comply with the applicable standards and best practices for the specific form type being used.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DELIVERY, STORAGE AND HANDLING

A. Maintain packaged materials clean, dry and protected against dampness, freezing and foreign matter.

B. Maintain materials and surrounding air temperature to at least 50 deg F before, during, and 48 hours after completion of masonry work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement: Natural color, Type II (normal) or Type IIA (air entraining), ASTM C150.

B. Water: Clean, non-staining, non-detrimental.

C. Hydrated Lime: Type S, ASTM C207. No substitutes permitted.

D. Mortar Aggregate: Standard masonry type except containing not more than 10 percent material passing through No. 100 sieve, ASTM C144. Measure damp and loose throughout batches.

E. Grout Aggregate, ASTM C404:

1. Fine aggregate (no. 4 through no. 100 sieves): Size 2.

2. Coarse aggregate (1/2 inch through no. 16 sieves): Size 8.

2.2 MORTAR MIXES

A. Refer to ASTM C270. Vary volumes of materials in mix design only slightly to assist workability:

1. Type S Mix (1,800 psi at 28 days): For reinforced masonry with high flexural bond strength. Use for all walls.

2. Type M Mix (2,500 psi at 28 days): For structural masonry, frost resistance, below grade masonry and masonry in contact with earth.

3. Mixing: Mix for a minimum of three (3) minutes.

B. Admixtures: Not permitted.

C. Color: Natural gray.

2.3 GROUT MIXES

A. Refer to ASTM C476. Vary volumes of materials in mix design only slightly to assist workability:

1. Reinforced masonry; 2,000 psi at 28 days.

2. Do not use antifreeze additives.

B. Mixing: Mix at least five (5) minutes to a slump of 10 inches plus or minus 1 inch at time of placement.

C. Admixtures: Not permitted.

D. Color: Natural gray.

PART 3 - EXECUTION

3.1 INSPECTION

A. Ensure substrates are clean and dry, free of frost, dirt, grease, oil, loose paint, or other foreign materials.

3.2 PREPARATION

A. Dampen masonry units before application of mortar.

B. Prepare and mix mortar and grout in accordance with manufacturer's instructions and the approved design mix.

3.3 INSTALLATION

A. Use mortar or grout within two (2) hours after mixing at temperatures of 80 deg F or greater or 2-1/2 hours at temperatures under 50 deg F.

B. Use fine grout for filling concrete masonry unit cores and when pumping is required.

C. Use fine or coarse grout for bond beams or where grout does not have to pass through openings less than two (2) inches.

3.4 CLEANING

A. Clean up excess mortar and grout from masonry units and surrounding areas during installation.

3.5 PROTECTION

A. Protect completed masonry work from damage until completion of the project. Use temporary protective covers if required.

3.6 QUALITY ASSURANCE

A. Engage a qualified independent testing and inspecting agency to inspect and test the quality of masonry work in accordance with the relevant standards.

B. CONTRACTOR shall submit mix designs for mortar and grout to agency for review and acceptance prior to starting any masonry work.

C. CONTRACTOR will coordinate with agency to allow opportunities for agency representatives to perform the following tasks:

    1. Inspect the preparation and installation of masonry work on a regular basis to verify conformance with the specifications and approved submittals.

    2. Perform tests on field-prepared mortar and grout as specified in this section and in accordance with ASTM C780 and ASTM C1019, respectively.

END OF SECTION

SECTION 04 22 00

CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units, reinforcement, anchorages, and accessories.

1.2 REFERENCES

A. ACI Standards:

1. 315 Details and Detailing of Concrete Reinforcement.

B. ASTM Standards:

1. A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
2. CSS Concrete Building Brick.
3. C90 Hollow Load-Bearing Concrete Masonry Units.
4. C145 Solid Load-Bearing Concrete Masonry Units.
5. D226 Asphalt—Saturated Organic Felt Used in Roofing and Waterproofing.
6. D1056 Flexible Cellular Materials –Sponge or Expanded Rubber.
7. D2000 Rubber Products in Automotive Applications.
8. D2287 Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.

C. AWS Standards:

1. D1.1 Structural Welding Code Steel.

D. BIA Standards:

1. A606 Cold Weather Masonry Construction.

E. UBC Standards:

1. Chapter 24 Masonry.

1.3 SUBMITTALS

A. Submit 10 Samples of units to illustrate color range and texture, Section 01 33 00.

B. Indicate bar sizes, spacing, locations, and quantities of reinforcing steel, and wire fabric, bending and cutting schedules, and support and spacing devices.

C. Prepare Shop Drawings under seal of a design professional licensed in the State of Utah and acceptable to ENGINEER.

D. Submit manufacturer's certificate that concrete masonry units and reinforcing steel materials meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PROJECT CONDITIONS

A. Cold weather: In accordance with BIA Publication A606 requirements protect materials from damage by rain, snow, inclement weather, wind, freezing temperatures, and other trades. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrate. Remove and replace masonry damaged by frost or freezing. No antifreeze materials permitted.

B. Protection:

1. Cover tops of masonry walls with tarp or reinforced plastic each day at end of work and when work is not in progress. Keep walls covered and protected until final wall copings are installed.

2. Brace and protect walls during erection against damage by storm and wind. Maintain bracing in place until permanent floors, walls and roof framing are installed.

C. Temperature: Temperature of masonry units when laid shall not be less than 20 deg F. Maintain masonry work above 50 deg F before, during, and 48 hours after completion. Do not use salamander heaters or other Petroleum type heaters that cause excessive drying or smoke. Use heaters on both sides of wall under construction.

D. Heating Materials: Heat materials to at least 50 deg F but not more than 160 deg F to produce material temperature of between 50 deg F and 160 deg F.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver pre-blended, dry mortar mix in moisture-resistant containers. Store in a dry location.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. Hollow Load Bearing Units: Grade N, Type I, light weight, ASTM C90.

B. Solid Load Bearing Units, Grade N, Type I, light weight, ASTM C145.

C. Decorative Units, ASTM C90 or C145:

1. Interior Location: Grade S, Type I, single scored horizontally, single scored vertically, double scored vertically, triple scored vertically, ribbed or ribbed and split as indicated.

2. Exterior Locations: Grade N units.

D. Concrete Brick: Grade N, Type I, normal weight, ASTM C55.

E. Masonry Units: Modular sized to 7-5/8 x 7-5/8 x 15-5/8 inches or as indicated; provide special units for 90-degree corners, bond beams, lintels, covered base, and bull-nose corners as required.

2.2 REINFORCEMENT, ANCHORS AND TIES

A. Single Wythe Joint Reinforcement: Truss type, galvanized steel, 3/16 inch side rods with No. 9 cross ties.

B. Double wythe walls without drip cross ties.

C. Masonry Joint Reinforcement: Ladder or truss type with 9-gauge side rods and 9-gauge cross rods.

D. Wall Ties: Corrosion-resistant, adjustable, of type and size recommended by manufacturer for application.

E. Reinforcement: Grade 60 deformed billet steel bars, ASTM A615.

2.3 MASONRY FLASHINGS

A. Plastic Flashings: Sheet polyethylene or PVC; 10 mil thick.

B. Copper and Kraft Paper Flashings: two (2) ounces per square foot copper bonded to layer of fiber reinforced asphalt and backed with Kraft paper.

C. Sheet Metal Flashing: Galvanized steel, 22 gage minimum.

D. Plastic and Kraft Paper Flashings: Three (3) mil thick sheet polyethylene bonded to layer of fiber reinforced asphalt and backed with Kraft paper.

E. Flexible Flashing: Composite, self-adhering stainless-steel flashing product or elastomeric flashing; non-staining; of type recommended by manufacturer for application.

2.4 ACCESSORIES

A. Nonmetallic Expansion Joint Strips: Grade RE41E1 premolded, flexible cellular neoprene rubber filler strips, ASTM D1056, capable of compression up to 35 percent of width and thickness indicated.

B. Premolded Control Joint Strips: Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall, Size and configuration as indicated:

1. Styrene-butadiene rubber compound complying with ASTM D2000, Designation 2AA-805, or

2. Polyvinyl chloride compound complying with ASTM D2287, General Purpose Grade, Designation PVC-63506.

C. Bond Breaker Strips: Type I (No. 15 asphalt-saturated organic roofing felt), ASTM D226.

D. Joint Filler: Closed cell polyethylene oversized 50 percent, self-expanding, 1 inch wide by maximum lengths.

E. Building Paper: Asphalt saturated felt 16-pound type, ASTM D226.

F. Nailing Strips: Western softwood, preservative treated, sized to masonry joints.

G. Weep Holes: PVC tubes or open vertical joints between units on bottom course.

2.5 MORTAR AND GROUT

A. Section 04 05 16 Masonry, Mortar, and Grout.

2.6 WATER REPELLENTS

A. Provide integral water repellent for masonry units and mortar admixtures.

PART 3 - EXECUTION

3.1 PREPARATION

A. Supply metal anchors to framing or structural erector where required and direct the placement of the anchors for anchoring the masonry work to other structural members.

B. Verify items provided by other sections of work are properly sized and located.

C. Establish lines, levels, and coursing. Protect from disturbance.

D. Provide temporary bracing during erection of masonry work. Maintain in place until building structure provides permanent bracing.

E. Provide safe and secure scaffolding, staging, and ladders that conform to current Laws and Regulations.

3.2 COURSING

A. Place masonry to lines and levels required.

B. Maintain masonry courses to uniform width. Make vertical and horizontal joints equal and of uniform thickness.

C. Unless indicated otherwise, lay concrete masonry units in running or stacked bond as indicated. Course one block unit and one mortar joint to equal eight (8) inches. Form concave, raked, flush, or beveled mortar joints as required.

D. Maintain masonry courses to uniform length. Break vertical continuity of head joints in adjacent courses by at least a quarter of a unit length.

3.3 PLACING AND BONDING

A. Lay masonry in full bed of mortar, properly jointed with other work. Do not butter corners of joints or make deep or excessive furrowing of mortar joints.

B. Fully bond intersections, external and internal corners.

C. Do not shift or tap masonry units after mortar has taken initial set. Where adjustment must be made, remove mortar and replace.

D. Remove excess mortar.

E. Perform job site cutting with masonry saws to provide straight unchipped edges. Do not break masonry unit corners or edges.

F. Do not install broken or cracked units.

G. Strike mortar joints of concrete masonry units flush where bitumen damp-proofing is applied.

3.4 REINFORCEMENT AND ANCHORAGES

A. Unless indicated otherwise, install horizontal joint reinforcement 16 inches on center; 24 inches on center if used in veneer. Joint reinforcement is in addition to bond beams.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend 16 inches, minimum, each side of opening.

C. Bond beams at all floors, roofs, 48 inches on center maximum, and at top of walls.

D. Lap joint reinforcement ends minimum six (6) inches. Extend 16 inches, minimum, each side of opening.

E. Embed wall ties in masonry backup for veneer at maximum 16 inches on center vertically and 18 inches on center horizontally. Place so that no single tie will support more than two (2) square feet of veneer. Place at maximum three (3) inches on center each way around perimeter of opening within 12 inches of openings. Use joint reinforcement for veneer ties on masonry walls.

F. Reinforce joint corners and intersections with reinforcement anchor systems.

3.5 REINFORCING STEEL

A. Place reinforcement, ACI 315 and UBC Chapter 24.

B. Locate reinforcing splices at points of minimum stress. Review location of splices with ENGINEER.

C. Weld reinforcement, AWS D1.1.

D. Place reinforcing bars supported and secured against displacement. Maintain position within 1/2 inch of true dimension.

E. Verify reinforcement is clean, free of scale, rust, dirt, and other foreign coatings that would reduce bond to grout.

3.6 TOLERANCES

A. Alignment of Columns and Pilaster: 1/4 inch maximum from true line.

B. Variation from Unit to Adjacent Unit: 1/32 inch maximum.

C. Variation from Plane of Wall: 1/4 inch in 10 feet and 1/2 inch in 20 feet or more.

D. Variation from Plumb: 1/4 inch per story non-cumulative, 1/2 inch maximum in two (2) stories or more.

E. Variation from Level Coursing: 1/8 inch in three (3) feet, 1/4 inch in 10 feet, 1/2 inch maximum.

F. Variation of Joint Thickness: 1/8 inch in three (3) feet.

G. Maximum Variance from Cross-Sectional Thickness of Walls: 1/4 inch plus or minus.

3.7 MASONRY FLASHINGS

A. Extend flashings through veneer, turn up minimum eight (8) inches and bed into mortar joints of masonry, seal substrate as required.

B. Lap end joints six (6) inches minimum and seal watertight.

C. Use flashing manufacturer's recommended sealant.

3.8 LINTELS

A. Furnish and install steel lintels as indicated.

B. Install precast concrete lintels as indicated.

C. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled. Construct or shop fabricate lintels using grout fill and reinforcing. Maintain eight (8) inches minimum bearing on each side of opening.

D. Do not splice reinforcing bars in lintels.

E. Allow lintels to reach full strength before removing temporary supports.

3.9 GROUTED COMPONENTS

A. Reinforce bond beams as indicated. Use "H" blocks for bond beams and "U" blocks for lintels.

B. Reinforce pilaster as indicated.

C. Lap splices minimum 40 bar diameters.

D. Place and consolidate grout fill without disturbing reinforcing. Grout lifts greater than eight (8) inches shall be mechanically vibrated. Do not consolidate by rodding or shaking the vertical bars.

E. At bearing points fill masonry cores with grout a minimum of 24 inches wide from bearing point to lower support member or bond beam.

3.10 CONTROL JOINTS

A. Do not continue horizontal joint reinforcing across control joints.

B. Form control joint by use of sheet building paper bond breaker one side fitted to hollow contour of block unit end. Fill created core with grout fill. Rake joint at exposed faces of rod and sealant.

C. Install resilient control joint in continuous lengths. Heat or solvent weld butt and corner joints in accordance with manufacturer's instructions.

3.11 BUILT-IN WORK

A. Build in metal door frames, fabricated metal frames, window frames, wood nailing strips, anchor bolts, plates, and other items. Place all anchor bolts in solid grouted cores.

B. Build items plumb and level.

C. Bed anchors of metal door and glazed frames in mortar joints. Fill frame voids solid with mortar. Fill masonry cores with grout for one core from framed openings.

D. Do not build in organic materials.

3.12 CUTTING AND FITTING

A. Modify completed work for chases, pipes, conduit, sleeves, grounds, and other items as required. Cooperate with other sections of work to provide correct size, shape, and location.

B. Obtain approval before modifying any area not indicated or where appearance or strength of masonry work may be impaired.

3.13 CLEANING AND SEALING

A. Brush off excess mortar as work progresses. Dry brush at the end of each day's work.

B. Final Cleaning: After mortar is thoroughly set and cured and damaged surfaces are repaired, clean sample wall area of approximately 20 square feet. Obtain ENGINEER's approval of sample cleaning before proceeding to clean masonry work:

1. Dry clean to remove large particles of mortar using wood paddles and scrapers. Use chisel or wire brush if necessary.

2. Scrub down wall with stiff fiber brush and either a solution of 1/2 cup of trisodium phosphate and 1/2 cup of household detergent dissolved in 1 gallon of water, or other approved masonry cleaner.

3. Rinse walls by washing off cleaning solution, dirt, and mortar crumbs using clean, 100 percent soluble pressurized water.

C. Sealing: Organo-Siloxane, Section 07 19 00 on indicated surfaces.

3.14 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

C. Maintain protective boards at exposed external corners that may be damaged by construction activities.

D. Provide protection without damaging completed work.

E. At day's end, cover unfinished walls to prevent moisture infiltration.

F. Protect adjacent finished surfaces from damage.

3.15 WARRANTY

A. Provide a material and labor warranty for a period of 2 years from Date of Substantial Completion.

END OF SECTION

Division 05 – Metals

SECTION 05 05 13

SHOP-APPLIED COATINGS FOR METAL

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Shop-applied coatings for structural and miscellaneous metalwork, including surface preparation, application, and finishing.

2. Galvanized coatings for structural and miscellaneous metalwork, including surface preparation and application.

1.2 RELATED SECTIONS

A. Not Applicable.

1.3 REFERENCES

A. American Society for Testing Materials (ASTM):

1. A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

2. A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

3. A385/A385M - Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).

4. A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

5. D16 – Standard Terminology for Paint, Related Coatings, Materials, and Applications.

6. D610 – Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces.

7. E376 - Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods.

B. Society for Protective Coatings (SSPC):

1. SP 1 – Solvent Cleaning.

2. SP 6/NACE No. 3 – Commercial Blast Cleaning.

3. SP 10/NACE No. 2 – Near-White Blast Cleaning.

4. PA 1 – Shop, Field, and Maintenance Painting of Steel.

C. American Institute for Steel Construction (AISC):

1. 303 – Code of Standard Practice for Steel Buildings and Bridges.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for each type of coating specified, including application instructions.

B. Certifications: Submit certification that coatings comply with specified requirements.

C. Test Reports: Submit test reports showing compliance with specified performance characteristics and physical properties.

D. Samples: Submit samples of each type and color of shop-applied coating for approval.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall have a minimum of 5 years of experience producing similar coatings.

B. Applicator Qualifications: Applicator shall have a minimum of 5 years of experience with application of similar coatings.

C. Mock-Up: Provide a mock-up of each coating system for approval prior to full application.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Store materials in a clean, dry area in accordance with manufacturer's instructions.

C. Protect materials during handling and application to prevent contamination and damage.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Primer: Rust-inhibitive primer conforming to [insert specific standard, e.g., SSPC Paint 25, Type I].

B. Intermediate Coat: [insert specific intermediate coat, if applicable].

C. Topcoat: High-performance topcoat conforming to [insert specific standard, e.g., SSPC Paint 36, Type II].

D. Zinc for Galvanizing: Conforming to ASTM B6, High Grade.

E. Galvanized Coating: Hot-dip galvanizing conforming to ASTM A123/A123M or ASTM A153/A153M.

2.2 COATING SYSTEMS

A. Coating System 1:

1. Primer: [Product Name], applied at [specified mil thickness].

2. Intermediate Coat: [Product Name], applied at [specified mil thickness].

3. Topcoat: [Product Name], applied at [specified mil thickness].

B. Coating System 2:

1. Primer: [Product Name], applied at [specified mil thickness].

2. Topcoat: [Product Name], applied at [specified mil thickness].

C. Galvanized Coating System:

1. Surface Preparation: Clean and prepare in accordance with ASTM A385/A385M.

2. Galvanized Coating: Hot-dip galvanizing conforming to ASTM A123/A123M for structural steel and ASTM A153/A153M for hardware.

2.3 FINISHES

A. Color and Gloss: As selected by ENGINEER from manufacturer's standard colors.

B. Texture: Smooth, uniform finish, free from defects.

2.4 REPAIR MATERIALS

A. Zinc-Rich Paint: Conforming to ASTM A780 for repair of damaged and uncoated areas of hot-dip galvanized coatings.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify that substrates are acceptable for application of coatings. Do not proceed with application until unacceptable conditions are corrected.

2.5 PREPARATION

A. Surface Preparation:

1. Clean and prepare surfaces in accordance with SSPC-SP 1 and SSPC-SP 6/NACE No. 3 or SSPC-SP 10/NACE No. 2, as required.

2. For Galvanized coatings, clean and prepare surfaces in accordance with ASTM A385/A385M.

B. Remove all grease, oil, dirt, loose rust, and other contaminants prior to coating application.

3.2 APPLICATION

A. Apply coatings in accordance with manufacturer's instructions and approved submittals.

B. Ensure even application without runs, sags, or other defects.

C. Apply each coat to the specified thickness and allow sufficient drying time between coats.

D. Use proper tools and equipment to ensure accurate and consistent coating application.

E. Galvanizing:

1. Perform hot-dip galvanizing in accordance with ASTM A123/A123M or ASTM A153/A153M.

2. Ensure proper immersion and coating thickness according to applicable standards.

3. Repair damaged and uncoated areas of hot-dip galvanized coatings in accordance with ASTM A780.

4. Apply zinc-rich paint to repaired areas to achieve a coating thickness equivalent to surrounding galvanized coating.

3.3 FIELD QUALITY CONTROL

A. Inspect applied coatings for compliance with project specifications.

B. Perform field tests to verify coating thickness, adhesion, and appearance.

C. For Galvanized coatings, perform field tests to verify coating thickness, adhesion, and appearance in accordance with ASTM E376.

D. Repair or replace any defective or damaged coatings at no additional cost to the OWNER.

3.4 CLEANING

A. Clean all coated surfaces and adjacent areas of any dirt, debris, or excess materials.

B. Dispose of all waste materials in accordance with local regulations.

3.5 PROTECTION

A. Protect coated surfaces from damage during construction activities.

B. Repair or replace any coatings damaged during construction at no additional cost to the OWNER.

3.6 DOCUMENTATION AND REPORTING

A. Maintain detailed records, and submit a final comprehensive report to OWNER, of all activities, including field inspections, and mil testing.

END OF SECTION

SECTION 05 05 23

METAL FASTENINGS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal fastenings for structural and miscellaneous metal fabrications.

2. Bolts, nuts, washers, screws, and anchors.

1.2 RELATED SECTIONS

05 05 13 – Shop-Applied Coatings for Metal

05 12 00 – Structural Steel Framing

05 50 00 – Metal Fabrications

1.3 REFERENCES

A. American Society for Testing Materials (ASTM):

1. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

2. ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.

3. ASTM F436 - Standard Specification for Hardened Steel Washers.

4. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for each type of fastening specified, including material specifications, strength characteristics, and finish.

B. Certificates: Submit certificates of compliance with the specified standards.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall have a minimum of 5 years of experience producing similar fastenings.

B. Installer Qualifications: Installer shall have a minimum of 5 years of experience with installation of similar fastenings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Store materials in a clean, dry area in accordance with manufacturer's instructions.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Structural Bolts:

1. ASTM A325 for standard high-strength bolts.

2. ASTM A490 for higher-strength applications.

B. Nuts:

1. Heavy hex nuts conforming to ASTM A563.

2. Finish to match bolts.

C. Washers:

1. Hardened steel washers conforming to ASTM F436.

2. Finish to match bolts.

D. Anchor Bolts:

1. Anchor bolts conforming to ASTM F1554, Grade 55 minimum.

2.2 FINISHES

A. Hot-Dip Galvanizing:

1. Bolts, nuts, and washers to be hot-dip galvanized in accordance with ASTM A153.

2. Touch-up materials for field repairs to be zinc-rich paint conforming to ASTM A780.

B. Electroplating:

1. Electroplated finishes for specific applications as required.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify that conditions are suitable for installation. Do not proceed until unsatisfactory conditions have been corrected.

2.3 INSTALLATION

A. Install fastenings in accordance with manufacturer's instructions and approved shop drawings.

B. Use proper tools and equipment to ensure secure and accurate placement.

C. Ensure that all fastenings are tightened to the specified torque values.

3.2 FIELD QUALITY CONTROL

A. Inspect installed fastenings to ensure they comply with project specifications.

B. If torque values are specified, inspections shall be performed to verify the torque has been achieved.

C. Test a representative sample of fastenings to confirm compliance with specified strength requirements. This requirement may be waived with written permission from the OWNER.

3.3 CLEANING

A. Clean all exposed fastenings and adjacent surfaces of any dirt, debris, or excess materials.

B. Dispose of all waste materials in accordance with local regulations.

3.4 PROTECTION

A. Protect installed fastenings from damage during construction activities.

B. Repair or replace damaged fastenings at no additional cost to the OWNER.

3.5 DOCUMENTATION AND REPORTING

A. Maintain detailed records, and submit a final comprehensive report to OWNER, of all activities, including field inspections, and testing.

END OF SECTION

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.
2. Field-installed shear connectors.
3. Grout.

B. Structural Steel Finishes:

1. Steel fully enclosed in walls and partitions, or not visible in completed construction need not be primed unless indicated otherwise on Drawings.
2. Visible, Dry Exposures: Anti-corrosive shop primer.
3. Visible Exterior or Wet Exposures: Either zinc-rich primer or hot-dip galvanize at CONTRACTOR's discretion, unless hot-dip galvanized only is indicated on Structural Drawings.

1.2 RELATED SECTIONS

A. Section 01 60 01 “Buy America Requirements” for special product requirements.

B. Section 05 31 00 “Steel Decking” for field installation of shear connectors through deck.

C. Section 05 50 00 “Metal Fabrications” for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications and other steel items not defined as structural steel.

D. Section 09 91 13 “Exterior Painting”, and Section 09 91 23 Interior Painting for field application of intermediate and topcoat finishes over primers applied in this Section.

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Manufacturers printed technical data indicating products provided that comply with requirements of the drawings.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Indicate material type for all structural shapes and plates.

2. Include layout, spacings, sizes thicknesses, and types of framing; fabrication; and fastening and anchorage details, including mechanical fasteners.

3. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

4. Include embedment Drawings.

5. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.

6. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.

7. Identify members and connections of the Seismic-Load-Resisting System.

8. Indicate locations and dimensions of protected zones.

9. Identify demand critical welds.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).

2. Electrode manufacturer and trade name, for demand critical welds.

D. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Informational Submittals:

1. Qualification Data: For Installer, fabricator, shop-painting applicators, and testing agency.

2. Welding certificates.

3. Mill test reports (MTRs) for structural steel, including chemical and physical properties.

4. Product Test Reports: For the following:

5. Bolts, nuts, and washers including mechanical properties and chemical analysis.

6. Direct-tension indicators.

7. Shear stud connectors.

8. Shop primers.

9. Non-shrink grout.

10. Survey of existing conditions.

11. Source quality-control reports.

12. Field quality-control and special inspection reports.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, or is accredited by the IAS Fabricator Inspection Program for Structural Steel (AC 172).

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program.

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or Endorsement P2 or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

E. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.

2. AISC 341 and AISC 341s1.

3. AISC 360.

4. RCSC's "Specification for Structural Joints Using High Strength Bolts."

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches.

2. Welded built-up members with plates thicker than 2 inches.

3. Column base plates thicker than 2 inches.

D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.9 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Prior to the start of steel framing work, and at the CONTRACTOR’s direction, meet at the site and review the installation procedures and coordination with other work.

2. Include CONTRACTOR, OWNER, OWNER's Testing and Inspection Agency, as well as any subcontractors or material technical service representative whose work, or products, must be coordinated with the steel framing work.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided OWNER's testing and inspecting agency observes repackaging and seals containers.

2. Clean and relubricate bolts and nuts that become dry or rusty before use.

3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F1852 fasteners and for retesting fasteners after lubrication.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Use ASTM designation for structural shapes and plates listed below unless noted otherwise in the plans.

1. W-Shapes: ASTM A992/A992M, ASTM A572/A572M, Grade 50, ASTM A529/A529M, Grade 50, or ASTM A913/A913M, Grade 50.

2. Channels, Angles, M and S-Shapes: ASTM A36/A36M.

3. Plate and Bar: ASTM A36/A36M ASTM A572/A572M, Grade 50.

4. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B, structural tubing.

5. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

6. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade C, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

   1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with plain finish.

B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, round head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade C, heave-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

   1. Finish: Plain.

C. Shear Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

D. Unheaded Anchor Rods: ASTM F1554, Grade 36 ASTM F1554, Grade 55, weldable.

   1. Configuration: Straight or Hooked as indicated on Drawings.

   2. Nuts: ASTM A563 heavy-hex carbon steel.

   3. Plate Washers: ASTM A36/A36M carbon steel.

   4. Washers: ASTM F436, Type 1, hardened carbon steel.

   5. Finish: Plain.

E. Threaded Rods: ASTM A36/A36M.

   1. Nuts: ASTM A563 heavy-hex carbon steel.

   2. Washers: ASTM F436, Type 1, hardened or ASTM A36/A36M carbon steel.

   3. Finish: Plain.

2.3 PRIMER

A. Anti-Corrosive Shop Primer: Either of following, compatible with finish paints specified to be used over it; use primer containing pigments that make it easily distinguishable from zinc-rich primer:

   1. Anti-Corrosive Alkyd Primer for Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

2. Rust-Inhibitive, Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

B. Zinc-Rich Primer: Either of following, compatible with finish paints specified to be used over it:

1. Organic Zinc-Rich Primer: Solvent based, one component, anti-corrosive primer complying with MPI#18.

2. Inorganic Zinc-Rich Primer: Inorganic based, anti-corrosive primer complying with MPI#19.

3. Epoxy Zinc-Rich Primer: Solvent based, two or three component, epoxy type complying with MPI#20.

C. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 or ASTM A780/A780M.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

1. Camber structural-steel members where indicated.

2. Fabricate beams with rolling camber up.

3. Identify high-strength structural steel according to ASTM A6/A6M and maintain markings until structural steel has been erected.

4. Mark and match-mark materials for field assembly.

5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

D. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3.

E. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch standard bolt holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.

2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

4. Grind sheared, punched, and flame-cut edges to remove burrs and provide smooth surface and eased edges.

5. Make intermittent welds appear continuous, using filler or additional welding.

6. Limit butt and plug weld projections to 1/16 inch.

7. Remove weld spatter, slivers, and similar surface discontinuities.

8. Remove blemishes and surface irregularities resulting from temporary braces or fixtures by filling or grinding, before cleaning, treating, and shop priming.

9. Grind tack welds smooth unless incorporated into final welds.

10. Remove backing and runoff tabs, and grind welds smooth.

11. Conceal fabrication and erection markings from view in the complete structure.

12. Make welds uniform and smooth.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using High Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: As indicated.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.

2. Surfaces to be field welded.

3. Surfaces of high-strength bolted, slip-critical connections.

4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).

5. Galvanized surfaces [unless indicated to be painted].

6. Corrosion-resisting (weathering) steel surfaces.

7. Surfaces enclosed in interior construction.

8. Surface indicated in the drawings to not be primed.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. Items Indicated to Receive Anti-Corrosive Shop Primer: SSPC-SP 3, "Power Tool Cleaning."

2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123/A123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing of smooth.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform shop tests and inspections.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Bolted Connections: Inspect and test shop-bolted connections according to RCSC's "Specification for Structural Joints Using High-Strength Bolts."

C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E165/E165M.

2. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

3. Ultrasonic Inspection: ASTM E164.

4. Radiographic Inspection: ASTM E94/E94M.

D. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.

2. Weld plate washers to top of baseplate.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by ENGINEER. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Minimize damage to shop priming during erection.

I. Remove welded tabs that are used for attaching temporary bracing and safety cabling that are exposed to view in the completed work. Take care to avoid any blemishes, holes, or unsightly surfaces resulting from the use of removal of temporary elements.

J. Grind tack welds smooth.

K. Remove backing and runoff tabs, and grind welds smooth.

L. Conceal fabrication and erection markings from view in the completed structure.

M. Remove weld spatter, slivers, and similar surface discontinuities.

N. Grind off butt and plug weld projections larger than 1/16 inch.

O. Continuous welds shall be of uniform size and profile.

P. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using High Strength Bolts" for bolt and joint type specified.

1. Joint Type: As indicated.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.

3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.

2. Verify weld materials and inspect welds.

3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Bolted Connections: Inspect bolted connections according to RCSC's "Specification for Structural Joints Using High Strength Bolts."

D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.

1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E165/E165M.

b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

c. Ultrasonic Inspection: ASTM E164.

d. Radiographic Inspection: ASTM E94/E94M.

E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

F. Prepare and test and inspection reports.

3.6 REPAIRS AND PROTECTION

A. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

   1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

3.7 DOCUMENTATION

A. Submit inspection reports, test reports, shop drawings, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed steel framing.

END OF SECTION

SECTION 05 31 00

STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof Deck.
2. Composite floor deck.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.
2. Section 05 12 00 “Structural Steel Framing” for shop- and field-welded shear connectors.
3. Section 05 50 00 “Metal Fabrications” for framing deck openings with miscellaneous steel shapes.

1.2 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of deck, accessory, and product indicated.
2. Shop Drawings:
    a. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

B. Informational Submittals:

1. Welding certificates.
2. Product certificates: For each type of steel deck. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

a. Power-actuated mechanical fasteners.

3. Evaluation Reports: For steel deck.

4. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, “Structural Welding Code – Sheet Steel.”

C. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its “Approval Guide, Building Materials” for Class 1 fire rating and Class 1-90 windstorm ratings.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2.2 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. SC Profiles, Inc.; a Blue Scope Steel company.

2. Verco Manufacturing Co.

3. Or equal.

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized-Steel Sheet (CONTRACTOR's discretion in lieu of Aluminum-Zinc-Allow-Coated Steel Sheet): ASTM A 653/A 653M, Structural Steel (SS), Grade 50, G60 zinc coating.

    a. Application: Where deck is not exposed to view from below in finished construction.

2. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 50, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: Gray top surface with white underside.

    b. Application: Where deck is exposed to view from below in finished construction and exposed surface will be field painted.

3. Aluminum-Zinc-Alloy-Coated Steel Sheet (CONTRACTOR's discretion in lieu of Galvanized-Steel Sheet): ASTM A 792/A 792M, Structural Steel (SS), Grade 50 minimum, AZ50 aluminum-zinc-alloy coating.

    a. Application: Where deck is not exposed to view from below in finished construction.

4. Deck Profile: As indicated.

5. Profile Depth: As indicated.

6. Design Uncoated-Steel Thickness: As indicated.

7. Span Condition: Triple span or more.

8. Side Laps: Interlocking seam.

2.3 COMPOSITE FLOOR DECK

A. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 50 minimum, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard white baked-on, rust-inhibitive primer.

2. Profile Depth: As indicated.

3. Design Uncoated-Steel Thickness: Minimum 0.0358 inch.

4. Span Condition: Triple span or more.

2.4 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for decks that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.

G. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inchminimum diameter.

H. Galvanizing Repair Paint: ASTM A 780 or SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight.

I. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:

1. Weld Diameter: 3/4 inch, nominal.

2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.

3. Weld Washers: Install weld washers at each weld location.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 inches, and as follows:

1. Mechanically clinch or button punch.

2. Fasten with a minimum of 1-1/2 inch long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

E. Flexible Closure Strips: Install flexible closure strips on top side of flutes at ends over beams, at drain penetrations, at cutouts for other penetrations, where indicated, and anywhere where interior building air could flow freely to flute troughs on top side of deck. Install with adhesive according to manufacturer's written instructions to ensure complete airtight closure.

3.4 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: 3/4 inch, nominal.

2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.

3. Weld Spacing: Space and locate welds as indicated.

4. Weld Washers: Install weld washers at each weld location.

B. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches, with end joints as follows:

1. End Joints: Lapped or butted at CONTRACTOR's option.

C. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to CONTRACTOR and ENGINEER.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at CONTRACTOR's expense, will be performed to determine compliance of corrected work with specified requirements.

3.6 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation and apply repair paint.

1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel framing and supports for operable partitions.
2. Steel framing and supports for overhead doors.
3. Steel framing and supports for countertops.
4. Steel tube reinforcement for half-high partitions.
5. Steel framing and supports for mechanical and electrical equipment.
6. Steel framing and supports for applications where framing and supports are not specified in other Sections.
7. Elevator hoist beams.
8. Steel shapes for supporting elevator door sills.
9. Shelf angles.
10. Elevator pit sump covers.
11. Miscellaneous steel trim.
12. Steel angle corner guards.
13. Steel edgings.
14. Loose bearing and leveling plates for applications where they are not specified in other Sections.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

1.2 RELATED SECTIONS

01 60 01 – Buy America Requirements

33 11 00 – Water Distribution and Transmission

33 31 00 – Sanitary Sewerage Systems

03 30 00 – Cast in Place Concrete

05 12 00 – Structural Steel Framing

09 91 13 – Exterior Painting

09 91 23 – Interior Painting

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. ASTM

1. A36/A36M - Standard Specification for Carbon Structural Steel.

2. A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

3. A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

4. A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod.

C. AWS D1.1/D1.1M - Structural Welding Code – Steel.

1.4 SUBMITTALS

A. Action submittals:

1. Product Data for items related to metal fabrications. Including, but not limited to the following:

a. Paint products.

b. Grout.

2. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

a. Steel framing and supports for operable partitions.

b. Steel framing and supports for overhead doors.

c. Steel framing and supports for countertops.

d. Steel tube reinforcement for half-high partitions.

e. Steel framing and supports for mechanical and electrical equipment.

f. Steel framing and supports for applications where framing and supports are not specified in other Sections.

g. Elevator hoist beams.

h. Steel shapes for supporting elevator door sills.

i. Shelf angles.

j. Elevator pit sump covers.

k. Miscellaneous steel trim.

l. Steel angle corner guards.

m. Steel edgings.

n. Loose bearing and leveling plates for applications where they are not specified in other Sections.

o. Loose steel lintels.

p. Anchor bolts indicated to be cast into concrete or built into unit masonry.

q. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer must have a minimum of 5 years' experience producing similar products and be certified to relevant standards.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 ACCEPTANCE

A. Not Applicable.

1.7 COORDINATION

A. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates and Bars: ASTM A 36/A 36M, ASTM A572/A572M, Grade 50.

C. W-Shapes: ASTM A992/A992M, ASTM A572/A572M, Grade 50, ASTM A529/A529M, Grade 50, or ASTM A913/A913M, Grade 50.

D. Channels, Angles, M and S-Shapes: ASTM A36/A36M.

E. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

F. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

G. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

2.2 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.

D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

2.3 MISCELLANEOUS MATERIALS

A. Anti-Corrosive Shop Primer: Either of following, compatible with finish paints specified to be used over it; use primer containing pigments that make it easily distinguishable from zinc-rich primer:

1. Anti-Corrosive Alkyd Primer for Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

2. Rust-Inhibitive, Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.5 STEEL SUPPORT FRAMING FOR OPERABLE PARTITIONS

A. Fabricate supports from continuous steel beams of sizes recommended by partition manufacturer with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

B. Shop Finish:

1. Anti-corrosive primer.

2. Exception: Primer not required where framing is completely concealed in interior wall or ceiling construction.

2.6 STEEL SUPPORT FRAMING FOR OVERHEAD DOORS

A. Fabricate supports for overhead doors in metal framed partitions walls as follows:

1. Support Posts: 4 inch square by 1/4 inch wall minimum, steel tube post with base plate and slip joint assembly at top, detailed to support ends of overhead door units.

a. Base Plate: 3/8 inch thick rectangular or square as indicated on Drawings, Drill baseplates at all 4 corners for 1/2 inch anchor bolts.

b. Slip Joint Assembly: Weldment, as indicated on Drawings, comprised of steel tube receptor sized to accept post and allow for only vertical movement of post in receptor. Attach receptor to overhead steel support angles sized to span between steel joist and beam or other deck support members.

c. Door Support Plates: Steel plates, angle, or other steel unit required to attach overhead door unit to steel post. Comply with door manufacturer's recommendations for support plate location and fastening details.

2. Furnish expansion anchors of type required for attachment to concrete floor slab or deck.

B. Shop Finish:

1. Anti-corrosive primer.

2. Exception: Primer not required where framing is completely concealed in interior wall or ceiling construction.

2.7 STEEL SUPPORT FRAMING FOR COUNTERTOPS

A. Fabricate "L" shaped steel tube weldments from two 24-inch lengths of 2-inch square, 3/16-inch wall steel tube. Attached tube, end to side, at 90-degree angle; butt weld joint all around.

1. Provide longer tube leg if indicated on Drawings.

B. Shop Finish:

1. Anti-corrosive primer.

2.8 STEEL TUBE SUPPORT FRAMING FOR HALF-HIGH PARTITIONS

A. Fabricate half-high wall support framing from square steel tubing 3-1/2 by 3-1/2 by 1/4 inch wall-thickness.

1. Cap wall supports with 1/4-inch- thick steel plate.

B. Fabricate support framing with 3/8-inch- thick steel baseplates for bolting to concrete slab. Drill baseplates at all 4 corners for 1/4-inch anchor bolts.

1. Where wall supports are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of support tubes.

2. For thru-bolted wall supports, provide backing plate fabricated same as baseplate.

C. Shop Finish:

1. Anti-corrosive primer.

2. Exception: Primer not required where framing is completely concealed in interior wall or ceiling construction.

2.9 STEEL FRAMING AND SUPPORTS FOR MECHANICAL AND ELECTRICAL EQUIPMENT / WHERE FRAMING AND SUPPORT NOT SPECIFIED IN OTHER SECTIONS

A. General:

1. Provide steel framing and supports not specified in other Sections as needed to complete the Work.

2. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

3. Fabricate units from slotted channel framing where indicated.

4. Furnish inserts for units installed after concrete is placed.

B. Shop Finish:

1. For Interior Dry Environment Locations:

a. Anti-corrosive primer.

2. For Exterior and Interior Wet Environment Locations:

a. Galvanized and primed with shop primer for galvanized steel.

C. Exception: Primer not required where framing is completely concealed in interior wall or ceiling construction.

2.10 STEEL ELEVATOR HOIST BEAMS

A. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive elevator.

B. Furnish inserts for units installed after concrete is placed.

C. Shop Finish:

1. Anti-corrosive primer.

2.11 STEEL SHAPES FOR SUPPORTING ELEVATOR DOOR SILLS

A. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive elevator door sills.

1. Furnish inserts for units installed after concrete is placed.

B. Shop Finish:

1. Anti-corrosive primer.

2.12 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.

2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Shop Finish:

1. Galvanized.

2. Exception: Primer not required where framing is completely concealed in interior wall or ceiling construction.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.13 ELEVATOR PIT SUMP COVERS

A. Fabricate from 3/16-inch plate with four 1-inch- diameter holes for water drainage and for lifting.

B. Provide steel angle supports as indicated.

C. Shop Finish:

1. Galvanized.

2.14 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Shop Finish:

1. Anti-corrosive primer.

2. Galvanized and primed with shop primer for galvanized steel.

2.15 STEEL ANGLE CORNER GUARDS

A. Unless otherwise indicated, fabricate units from steel angle shapes of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Shop Finish:

1. Anti-corrosive primer.

2.16 STEEL EDGINGS

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Shop Finish:

1. Galvanized.

2.17 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Shop Finish:

1. Galvanized.

2.18 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Shop Finish:

1. Galvanized.

2.19 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

B. Shop Finish:

1. Galvanized.

2.20 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.21 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean items of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Items Indicated to Receive Anti-Corrosive Shop Primer: SSPC-SP 3, "Power Tool Cleaning."

2. Other Items: SSPC-SP 3, "Power Tool Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Framing for Operable Partitions: Anchor supports securely to, and rigidly brace from, building structure.

C. Framing for Overhead Doors: Anchor supports securely to, and rigidly brace from, building structure.

3.3 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with non-shrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

3.5 FIELD QUALITY CONTROL

A. Testing:

1. Conduct non-destructive testing (NDT) of welds to ensure integrity and compliance with specifications.

2. Perform load tests on installed assemblies as required.

B. Inspection:

1. Perform inspections at various stages of fabrication and installation to ensure compliance with project specifications and industry standards.

2. Document all test results and inspection findings.

3. Conduct a final inspection with the Architect/Engineer to ensure compliance with specifications and project requirements.

C. Obtain final approval and acceptance of the installed systems.

3.6 CLEANING

A. Remove excess material and debris from the site.

B. Clean the surface of installed metal components to remove dirt, stains, and other contaminants.

3.7 PROTECTION

A. Protect installed systems from damage during the remainder of construction activities.

3.8 DOCUMENTATION

A. Submit test reports, fabrication records, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of installed systems.

END OF SECTION

SECTION 05 50 01

METAL BOLLARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel bollards permanently set with anchored base plates.
2. Steel bollard permanently set in preset sleeves.
3. Steel bollards permanently set in core-drilled holes.
4. Steel bollards permanently set in concrete footings.
5. Steel bollards, removable, and set using preset sleeves.

B. Products furnished, but not installed, under this Section include the following:

1. Steel pipe sleeves indicated to be cast into concrete or built into unit masonry.

1.2 RELATED SECTIONS

01 60 01 – Buy America Requirements

03 30 00 – Cast-in-Place Concrete

05 12 00 – Structural Steel Framing

05 50 00 – Metal Fabrications

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. ASTM:

1. A36/A36M - Standard Specification for Carbon Structural Steel.
2. A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
4. A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod.

5. F3016 - Standard Specification for Crash-Rated Bollards.

1.4 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Show fabrication and installation details. Provide Shop Drawings for the following:

a. Steel bollards permanently set with anchored base plates.

b. Steel bollard permanently set in preset sleeves.

c. Steel bollards permanently set in core-drilled holes.

d. Steel bollards permanently set in concrete footings.

e. Steel bollards, removable, and set using preset sleeves.

f. Steel pipe sleeves indicated to be cast into concrete or built into unit masonry.

B. Product Data: Manufacturer’s technical data for bollards, finishes, and related components.

C. Samples: Physical samples of bollard finishes and materials for approval.

D. Test Reports: Certified test reports demonstrating compliance with specified standards, particularly for crash-rated bollards.

E. Manufacturer’s Instructions: Detailed instructions for the installation, operation, and maintenance of bollards.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer must have a minimum of 5 years’ experience producing similar products and be certified to relevant standards.

B. Installer Qualifications: Installer must have a minimum of 3 years’ experience performing similar work and be licensed as required by local authorities.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 COORDINATION

A. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

D. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.2 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.

D. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

2.3 MISCELLANEOUS MATERIALS

A. Anti-Corrosive Shop Primer: Either of following, compatible with finish paints specified to be used over it; use primer containing pigments that make it easily distinguishable from zinc-rich primer:

1. Anti-Corrosive Alkyd Primer for Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

2. Rust-Inhibitive, Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

D. Concrete: Comply with requirements in Section 03 30 00 Cast-in-Place Concrete for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.5 STEEL BOLLARDS PERMANENTLY SET WITH ANCHORED BASE PLATES

A. Fabricate metal bollards from Schedule 40 steel pipe unless indicated otherwise on Drawings.

1. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.

2. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Unless indicated otherwise on Structural Drawings, fabricate bollards with 1/2 inch thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

C. Shop Finish:

1. Anti-corrosive primer for interior dry exposures.

2. Galvanized for exterior exposures and interior wet exposures.

2.6 STEEL BOLLARDS PERMANENTLY SET IN PRESET SLEEVES

A. Fabricate metal bollards from Schedule 40 steel pipe unless indicated otherwise on Drawings.

1. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.

2. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch- thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.

C. Shop Finish:

1. Anti-corrosive primer for interior dry exposures.

2. Galvanized for exterior exposures and interior wet exposures.

2.7 STEEL BOLLARDS PERMANENTLY SET IN CORE-DRILLED HOLES

A. Fabricate metal bollards from Schedule 40 steel pipe unless indicated otherwise on Drawings.

1. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.

2. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Shop Finish:

1. Anti-corrosive primer for interior dry exposures.

2. Galvanized for exterior exposures and interior wet exposures.

2.8 STEEL BOLLARDS, PERMANENTLY SET IN CONCRETE FOOTINGS

A. Fabricate metal bollards from Schedule 40 steel pipe unless indicated otherwise on Drawings.

1. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.

2. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Shop Finish:

1. Anti-corrosive primer for interior dry exposures.

2. Galvanized for exterior exposures and interior wet exposures.

2.9 STEEL BOLLARDS, REMOVABLE, SET USING PRESET SLEEVES

A. Fabricate metal bollards from Schedule 40 steel pipe unless indicated otherwise on Drawings.

1. Cap bollards with 1/4-inch- thick steel plate.

2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.

3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Recessed Sleeve: Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch- thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.

C. Projecting Sleeve: Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 1/4-inch wall-thickness steel tubing with an OD approximately 1/16 inch less than ID of bollards. Match drill sleeve and bollard for 3/4-inch steel machine bolt.

D. Shop Finish:

1. Anti-corrosive primer for interior dry exposures.

2. Galvanized for exterior exposures and interior wet exposures.

2.10 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.11 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean items of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Items Indicated to Receive Anti-Corrosive Shop Primer: SSPC-SP 3, "Power Tool Cleaning."

2. Other Items: SSPC-SP 3, "Power Tool Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING METAL BOLLARDS PERMANENTLY SET USING ANCHORED BASE PLATES

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

B. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.

1. Embed anchor bolts at least 4 inches in concrete.

C. Fill bollards solidly with concrete, mounding top surface to shed water.

3.3 INSTALLING METAL BOLLARDS PERMANENTLY SET USING PRESET SLEEVES

A. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

B. Fill bollards solidly with concrete, mounding top surface to shed water.

3.4 INSTALLING METAL BOLLARDS PERMANENTLY SET IN CORE DRILLED HOLES

A. Anchor bollards in concrete in formed or core-drilled holes not less than 8 inches deep and 3/4 inch larger than OD of bollard. Fill annular space around bollard solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

B. Fill bollards solidly with concrete, mounding top surface to shed water.

3.5 INSTALLING METAL BOLLARDS PERMANENTLY SET IN CONCRETE FOOTINGS

A. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

B. Fill bollards solidly with concrete, mounding top surface to shed water.

3.6 INSTALLING METAL BOLLARDS, REMOVABLE, SET USING PRESET SLEEVES

A. Anchor external sleeves for removable bollards in concrete with pipe sleeves preset and anchored into concrete.

B. Place removable bollards into sleeves.

C. Anchor internal sleeves for removable bollards in concrete by inserting in pipe sleeves preset into concrete. Fill annular space around internal sleeves solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward internal sleeve.

D. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.

E. Place removable bollards over internal sleeves and secure with 3/4-inchmachine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. OWNER furnishes padlocks.

3.7 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

3.8 FIELD QUALITY CONTROL

A. Testing:

1. Conduct necessary tests to ensure compliance with crash-rating specifications, if applicable.

B. Inspection:

1. Perform inspections at various stages of installation to ensure compliance with project specifications and industry standards.

2. Document all test results and inspection findings.

3. Conduct a final inspection with the Architect/Engineer to ensure compliance with specifications and project requirements.

C. Obtain final approval and acceptance of the installed bollards.

3.9 CLEANING

A. Remove excess material and debris from the site.

B. Clean the surface of installed bollards to remove dirt, stains, and other contaminants.

3.10 PROTECTION

A. Protect installed bollards from damage during the remainder of construction activities.

3.11 DOCUMENTATION

A. Submit test reports, installation records, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of installed bollards.

END OF SECTION

SECTION 05 51 13

CONCRETE FILLED METAL PAN STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preassembled steel stairs with concrete-filled treads for the following:

a. Stair #1, interior exposure.

b. Stair #2, interior exposure.

1.2 RELATED SECTIONS

01 40 00 - Quality Requirements

01 60 01 – Buy America Requirements

03 30 00 - Cast-in-Place Concrete

05 52 13 – Pipe and Tube Railings

05 50 00 – Metal Fabrication

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. ASTM

1. A36/A36M - Standard Specification for Carbon Structural Steel.

2. A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. C94/C94M - Standard Specification for Ready-Mixed Concrete.

C. AWS D1.1/D1.1M - Structural Welding Code – Steel

1.4 SUBMITTALS

A. Action Submittals:

a. Product Data: Manufacturer’s technical data for metal components, finishes, and related items.

2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

3. Delegated-Design Submittal: For stairs and railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Informational Submittals:

1. Welding certificates.

C. Manufacturer's Instructions: Detailed instructions for the installation, operation, and maintenance of metal pan stairs.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 ACCEPTANCE

A. Not Applicable.

1.7 COORDINATION

A. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate locations of hanger rods and struts with other work so that they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 Quality Requirements, to design stairs and railings to the extent not shown on Structural Drawings.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.

2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.

3. Uniform and concentrated loads need not be assumed to act concurrently.

4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.

5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ft. applied in any direction.

b. Concentrated load of 200 lbf applied in any direction.

c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.

b. Infill load and other loads need not be assumed to act concurrently.

D. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: As indicated on Structural Drawings.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.

D. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

E. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25, unless another grade is required by design loads; exposed.

F. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30, unless another grade is required by design loads.

2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

D. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

2.4 MISCELLANEOUS MATERIALS

A. Anti-Corrosive Shop Primer: Either of following, compatible with finish paints specified to be used over it; use primer containing pigments that make it easily distinguishable from zinc-rich primer:

1. Anti-Corrosive Alkyd Primer for Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

2. Rust-Inhibitive, Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

B. Concrete Materials and Properties: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.

C. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.

D. Welded Wire Reinforcement: ASTM A 185/A 185M, 6 by 6 inches, W1.4 by W1.4, unless otherwise indicated.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.

2. Use connections that maintain structural value of joined pieces.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Weld exposed corners and seams continuously unless otherwise indicated.

5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 3 welds: partially dressed weld with spatter removed.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

2.6 STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Service Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel channels unless indicated otherwise on Structural Drawings.

a. Provide closures for exposed ends of channel stringers.

2. Construct platforms of steel channel headers and miscellaneous framing members as needed to comply with performance requirements unless indicated otherwise on Structural Drawings.

3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers.

4. Where stairs are enclosed by gypsum board shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.067 inch.

1. Steel Sheet: Uncoated cold -rolled steel sheet unless otherwise indicated.

2. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.

3. Shape metal pans to include nosing integral with riser.

4. At CONTRACTOR's option, provide stair assemblies with metal pan subtreads filled with reinforced concrete during fabrication.

5. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

2.7 STAIR RAILINGS

A. Comply with applicable requirements in Section 05 52 13 "Pipe and Tube Railings."

1. Connect posts to stair framing by direct welding unless otherwise indicated.

B. Connect posts to stair framing by direct welding unless otherwise indicated.

2.8 FINISHES

A. Finish metal stairs after assembly.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."

C. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLING METAL PAN STAIRS

1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

2. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

3. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

4. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

5. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

6. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

7. Place and finish concrete fill for treads and platforms to comply with Section 03 30 00 "Cast-in-Place Concrete."

3.2 INSTALLING RAILINGS

A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

   1. Anchor posts to steel by welding to steel supporting members.

   2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with post-installed anchors and bolts.

B. Attach handrails to wall with wall brackets. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as follows:

   1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

   2. For hollow masonry anchorage, use toggle bolts.

3. For steel-framed partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.

4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

3.3 FIELD QUALITY CONTROL

A. Testing:

1. Conduct necessary tests to ensure concrete strength and adhesion to the metal pans.

B. Inspection:

1. Perform inspections at various stages of installation to ensure compliance with project specifications and industry standards.

2. Document all test results and inspection findings.

3. Conduct a final inspection with the Architect/Engineer to ensure compliance with specifications and project requirements.

C. Obtain final approval and acceptance of the installed stairs.

3.4 CLEANING

A. Remove excess material and debris from the site.

B. Clean the surface of installed metal components to remove dirt, stains, and other contaminants.

3.5 PROTECTION

A. Protect installed stairs from damage during the remainder of construction activities.

3.6 DOCUMENTATION

A. Submit test reports, installation records, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of installed stairs.

END OF SECTION

SECTION 05 52 13

PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section includes requirements for the design, fabrication, and installation of pipe and tube railings for various applications, including stairs, ramps, balconies, and other areas requiring guardrails or handrails.

B. Railing Finishes:

1. Dry Exposures: Anti-corrosive shop primer.

2. Exterior or Wet Exposures: Either zinc-rich primer or hot-dip galvanize at CONTRACTOR's discretion.

1.2 RELATED SECTIONS

01 40 00 - Quality Requirements

01 60 01 – Buy America Requirements

05 50 00 – Metal Fabrication

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. ASTM

1. A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

2. A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. A276 – Standard Specification for Stainless Steel Bars and Shapes.

4. B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

5. A153/A 153M for hot-dip galvanized hardware.

C. AWS D1.1/D1.1M – Structural Welding Code – Steel

D. National Association of Architectural Metal Manufacturers (NAAMM) – Metal Finishes Manual for Architectural and Metal Products

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For the following:

   a. Grout, anchoring cement, and paint products.

2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

3. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

4. Submit calculations, including analysis data signed and sealed by the party responsible for their preparation.

5. Samples for Initial Selection: For products involving selection of color, texture, or design.

6. Samples for Verification: For each type of exposed finish required.

   a. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.

   b. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.

      1) Show method of connecting members at intersections.

7. Qualification Data: For qualified professional engineer.

8. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

9. Welding certificates.

10. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

11. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer must have a minimum of 5 years' experience producing similar products and be certified to relevant standards.

B. Installer Qualifications: Installer must have a minimum of 3 years' experience performing similar work and be licensed as required by local authorities.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 ACCEPTANCE

A. Not Applicable.

1.7 COORDINATION

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.8 TRADE CONTRACTOR QUALITY CONTROL

A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

3. AWS D1.6, "Structural Welding Code - Stainless Steel."

D. Standards: comply with the applicable provisions and recommendations of the following.

1. American Institute of Steel Construction (AISC) "Manual of Steel Construction".

2. American Iron and Steel Institute (AISI) "Cold Formed Steel Design Manual".

3. National Association of Architectural Metal Manufacturers (NAAMM):

a. AMP-521 "Pipe Handrails and Railing Systems Manual including Round Tube."

E. Regulatory Requirements: Comply with the requirements of Part 1910 of the Occupational Safety and Health Standards (OSHA), and the American Disabilities Act (ADA) as applicable to handrails and the protection of openings.

F. Provide qualified engineer licensed in the State of Utah for the design of rails.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.10 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Steel Pipe and Tube Railings:

1. Source Limitations: Obtain each type of railing from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 Quality Requirements, to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf / ft. applied in any direction.

b. Concentrated load of 200 lbf applied in any direction.

c. Uniform and concentrated loads need not be assumed to act concurrently.

d. Test in accordance to ASTM E935.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.

b. Infill load and other loads need not be assumed to act concurrently.

c. Test in accordance to ASTM E935.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F for ambient; and 180 deg F for surface.

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

2.3 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.4 STEEL AND IRON

A. Tubing: ASTM A 500 (cold formed) or ASTM A 513.

B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations and where indicated.

C. Plates, Shapes, and Bars: ASTM A 36/A 36M.

D. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

E. Brackets, Flanges, and Anchors:

1. Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2. Provide brackets with 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.5 FASTENERS

A. General: Provide the following:

1. Steel Railings:

a. Hot-Dip Galvanized: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

1. Material for Dry Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

2. Material for Wet Interior and Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.6 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Anti-Corrosive Shop Primer: Either of the following, compatible with finish paints specified to be used over it; use primer containing pigments that make it easily distinguishable from zinc-rich primer.

1. Anti-Corrosive Alkyd Primer for Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

2. Rust-Inhibitive, Water-Base Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

E. Zinc-Rich Primer: Either of following, compatible with finish paints specified to be used over it:

1. Organic Zinc-Rich Primer: Solvent based, one component, anti-corrosive primer complying with MPI#18.

2. Inorganic Zinc-Rich Primer: Inorganic based, anti-corrosive primer complying with MPI#19.

3. Epoxy Zinc-Rich Primer: Solvent based, two or three component, epoxy type complying with MPE#20.

F. Non-shrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

G. Anchoring Cement: Factory-packaged, non-shrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use for the following locations:

a. Exterior locations.

b. Interior locations subject to water spray or immersion.

2.7 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove flux immediately.

4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

H. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

I. Form Changes in Direction as Follows:

1. As detailed.

J. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

K. Close exposed ends of railing members with prefabricated end fittings.

L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

O. For removable railing posts, fabricate slip-fit sockets from steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.

P. For railing posts set in concrete, provide steel sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.

Q. For removable railing posts, fabricate slip-fit sockets from steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.

1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railing.

R. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.9 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize steel railings, including hardware, after fabrication.

2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.

3. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.

4. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, galvanize anchors to be embedded in exterior concrete or masonry.

E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below:

1. Railings Indicated to Receive Anti-Corrosive Shop Primer: SSPC-SP 3, "Power Tool Cleaning."

2. Railings Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.

3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

A. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

   1. Steel Railings: Finish anchorage joint as follows:

      a. Leave anchorage joint exposed with 1/8-inch buildup, sloped away from post.

B. Anchor posts to surfaces indicated with oval or rectangular flanges, angle type flanges, or floor type flanges as required by conditions, connected to posts and to supporting members as follows:

   1. Steel Railings:

      a. Attach posts using fittings of type indicated on Drawings.

C. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

D. Secure bolted post flanges to building construction as follows:

   1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

   2. For hollow masonry anchorage, use toggle bolts.

   3. For Steel-Framed Walls, Parapets and Similar Structures: One or more of the following as applicable for conditions indicated on Drawings:

      a. Use hanger or lag bolts set into wood backing between framing members (e.g. studs). Coordinate with framing installation to locate backing members.

      b. Use self-tapping screws fastened to steel framing or to concealed steel reinforcements.

c. Use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.5 ATTACHING RAILINGS

A. Anchor railing ends to walls, partitions, and similar building elements indicated with round or square flanges by one or more of the following:

1. With flanges bolted or screwed to wall construction and welded to railing ends.

2. With flanges welded to metal substrate and welded to railing ends.

B. Attach railings to wall with midrail wall brackets. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Anchor brackets by one or more of the following:

1. With brackets bolted or screwed to wall construction and welded to railing.

2. With bracket welded to metal substrate and welded to railing.

C. Secure handrails, wall brackets, and railing end flanges to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

2. For hollow masonry anchorage, use toggle bolts.

3. For steel-framed partitions, walls, parapets and similar construction us one or more of the following as applicable for conditions indicated on Drawings:

a. Use hanger or lag bolts set into wood backing between framing members (e.g. studs). Coordinate with framing installation to locate backing members.

b. Use self-tapping screws fastened to steel framing or to concealed steel reinforcements.

c. Use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.6 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

3.7 FIELD QUALITY CONTROL

A. Testing:

1. Conduct necessary tests to ensure compliance with specified strength and stability requirements.

B. Inspection:

1. Perform inspections at various stages of installation to ensure compliance with project specifications and industry standards.

2. Document all test results and inspection findings.

3. Conduct a final inspection with the Architect/Engineer to ensure compliance with specifications and project requirements.

C. Obtain final approval and acceptance of the installed railings.

3.8 REPAIR

A. Any damage to coatings and linings must be repaired within a specified time period to avoid potential corrosion and degradation.

B. Manufacturer to provide guidelines on the repair of damaged coatings and the criteria for replacement vs repair.

C. Repairs to any pipe and tube railings discovered shall be repaired at no cost to the OWNER.

3.9 CLEANING

A. Remove excess material and debris from the site.

B. Clean the surface of installed railings to remove dirt, stains, and other contaminants.

3.10 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

3.11 DOCUMENTATION

A. Submit test reports, installation records, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of installed railings.

END OF SECTION

Division 08 – Doors

SECTION 08 31 13

ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access doors and frames for walls and ceilings.

B. Schedule: Provide access door and frames at following installation locations:

1. Interior Non-Fire-Rated Walls:
    a. Equipment Accessed: Piping Shut-Off Valves (See Note 2).
        1) Type: Flush Access Doors and Frames with Exposed Flanges.
        2) Nominal Size: 12 inches square.
    b. Equipment Accessed: Clean-Outs (See Note 2).
        1) Type: Flush Access Doors and Frames with Exposed Flanges.
        2) Nominal Size: 12 inches square.
2. Interior Fire-Rated Walls (See Note 1):
    a. Equipment Accessed: Piping Shut-Off Valves (See Note 2).
        1) Type: Flush, Uninsulated, Fire-Rated Access Doors and Frames with Exposed Flanges.
        2) Nominal Size: 12 inches square.
    b. Equipment Accessed: Clean-Outs (See Note 2).
        1) Type: Flush Access Doors and Frames with Exposed Flanges.
        2) Nominal Size: 12 inches square.
3. Interior Non-Fire-Rated Gypsum Board Ceilings:
    a. Equipment Accessed: Manual Volume Dampers (See Note 3).
        1) Type: Flush Access Doors and Frames with Exposed Flanges.
        2) Nominal Size: 18 inches square.
    b. Equipment Accessed: VAV Terminal Units (See Note 3).
        1) Type: Flush Access Doors and Frames with Exposed Flanges.

2) Nominal Size: 18 inches square.

c. Equipment Accessed: Combination Fire/Smoke dampers (See Note 3).

1) Type: Flush Access Doors and Frames with Exposed Flanges.

2) Nominal Size: 18 inches square.

d. Equipment Accessed: Piping Shut-Off Valves (See Note 2).

1) Type: Flush Access Doors and Frames with Exposed Flanges.

2) Nominal Size: 12 inches square.

e. Equipment Accessed: Clean-Outs (See Note 2).

1) Type: Flush Access Doors and Frames with Exposed Flanges.

2) Nominal Size: 12 inches square.

f. Equipment Accessed: Fan Coil Units.

1) Type: Flush Access Doors and Frames with Exposed Flanges.

2) Nominal Size: 24 inches square.

4. Notes:

a. Note 1: In fire-resistance rated building elements provide access doors and frames with fire rating not less than that of adjacent construction.

b. Note 2: Reference Plumbing Drawings.

c. Note 3. Reference Mechanical HVAC Drawings.

C. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.

1.2 REFERENCES

A. Related Documents

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of product.

a. Include construction details, fire ratings, materials, individual components and profiles, and finishes.

2. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

B. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

B. Flush Access Doors with Exposed Flanges:

1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.

2. Locations: Wall and ceiling.

3. Door Size: No less than indicated in Schedule above.

4. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage.

a. Finish: Factory prime.

b. Application: In dry exposures.

5. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch, 16 gage.

a. Finish: Factory prime.

b. Application: In humid exposures, except shower rooms.

6. Stainless-Steel Sheet for Door: Nominal 0.062 inch, 16 gage.
    a. Finish: No. 4.
    b. Application: In shower rooms.
7. Frame Material: Same material, thickness, and finish as door.
8. Hinges: Manufacturer's standard.
9. Hardware:
    a. Latch:
        1) Cam latch operated by screwdriver.

C. Fire-Rated, Flush Access Doors with Exposed Flanges:

1. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
2. Locations: Wall.
3. Fire-Resistance Rating: Not less than that of adjacent construction.
4. Uncoated Steel Sheet for Door: Nominal 0.036 inch, 20 gage.
    a. Finish: Factory prime.
    b. Application: In dry exposures.
5. Metallic-Coated Steel Sheet for Door: Nominal 0.040 inch, 20 gage.
    a. Finish: Factory prime.
    b. Application: In humid exposures, except shower rooms.
6. Stainless-Steel Sheet for Door: Nominal 0.038 inch, 20 gage.
    a. Finish: No. 4.
    b. Application: In shower rooms.
7. Frame Material: Same material, thickness, and finish as door.
8. Hinges: Manufacturer's standard.
9. Hardware:
    a. Latch:
        1) Slam latch operated by screwdriver.

2.3 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

D. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines or blend into finish.

E. Frame Anchors: Same type as door face.

F. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. Provide mounting holes in frames for attachment of units to metal or wood framing.

2. Provide mounting holes in frame for attachment of masonry anchors.

D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

2.5 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Steel and Metallic-Coated-Steel Finishes:

1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

D. Stainless-Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

2. Directional Satin Finish: No. 4. Grind and polish surfaces to produce uniform finish, free of cross scratches.

a. Run grain of directional finishes with long dimension of each piece.

b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Install doors flush with adjacent finish surfaces.

3.3 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION

SECTION 08 33 23

OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Service doors, manually operated, including Door 137C.

2. Service doors, motor operated, including Doors 002D, 021B.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.

2. Section 05 50 00 “Metal Fabrications” for miscellaneous steel supports.

1.2 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type and size of overhead coiling door and accessory.

a. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.

b. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

2. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

a. Include plans, elevations, sections, and mounting details.

b. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

c. Include points of attachment and their corresponding static and dynamic loads imposed on structure.

d. Show locations of controls, locking devices, and other accessories.

e. Include diagrams for power, signal, and control wiring.

3. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:

a. Curtain slats.

B. Closeout Submittals

1. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

B. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

1. Obtain operators and controls from overhead coiling door manufacturer.

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 or UL 10B.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

2. Temperature-Rise Limit: At exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

3. Smoke Control: In corridors and smoke barriers, provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. (0.01524 cu. m/s x sq. m) of door opening at 0.10-inch wg (24.9 Pa) for both ambient and elevated temperature tests.

4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC A117.1.

1.5 ACCEPTANCE

A. Not Applicable

PART 2 - PRODUCTS

2.1 MANUFACTURERS, GENERAL

A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

1. Obtain operators and controls from overhead coiling door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.

1. Testing: According to ASTM E 330.

2. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.

B. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.0.

2.3 SERVICE DOORS NON-FIRE RATED, NOT INSULATED, MANUALLY OPERATED

A. Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. C.H.I. Overhead Doors.

b. Clopay Building Products.

c. Raynor.

d. Wayne-Dalton Corp.

B. Operation Cycles: Door components and operators capable of operating for not less than 10,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

C. Door Curtain Slats:

1. Slat Material:

a. Aluminum: ASTM B 209 sheet or ASTM B 221 extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch; and as required.

2. Profile: Flat.

3. Center-To-Center Height: 1-7/8-inch to 3-1/4-inch.

4. Gasket Seal. Manufacturer's standard continuous gaskets between slats.

D. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick.

1. Fabricate from aluminum extrusions.

2. Finish to match door.

E. Curtain Jamb Guides: Aluminum with exposed finish matching curtain slats.

F. Hood: Match curtain material and finish.

1. Shape: Square.

2. Mounting: As shown on Drawings.

3. Material:

a. Aluminum: 0.040-inch- thick aluminum sheet complying with ASTM B 209, of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.

G. Manual Door Operator: Equip door with manual door operator by door manufacturer.

1. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25-lbf force for door operation. Include the following:

a. Alloy-steel hand chain with chain holder secured to operator guide.

H. Curtain Accessories: Equip door with the following:

1. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.

I. Door Finish:

1. Aluminum, Interior Doors: Clear anodized.

2.4 SERVICE DOORS NON-FIRE RATED, NOT INSULATED, MOTOR OPERATED

A. Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Alpine Overhead Doors, Inc.

    b. C.H.I. Overhead Doors.

    c. Clopay Building Products.

    d. Cookson Company.

    e. Cornell Iron Works, Inc.

    f. McKeon Rolling Steel Door Company, Inc.

    g. Wayne-Dalton Corp.

B. Operation Cycles: Door components and operators capable of operating for not less than 50,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

C. Door Curtain Slats:

1. Slat Material:

    a. Galvanized Steel at Door 002D: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 zinc coating; nominal sheet thickness (coated) of 0.028 inch; and as required.

    b. Aluminum at Door 021B: ASTM B 209 sheet or ASTM B 221 extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch; and as required.

2. Profile: Flat.

3. Center-To-Center Height: 1-7/8-inch to 3-1/4-inch.

D. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick.

1. Door 002D: Fabricate from hot-dip galvanized steel.

2. Door 021B: Fabricate from aluminum extrusions.

3. Finish to match door.

E. Curtain Jamb Guides: Following material with exposed finish matching curtain slats.

1. At Door 002D: Galvanized steel.

2. At Door 021B: Aluminum.

F. Hood: Match curtain material and finish.

1. Shape: Round.

2. Mounting: As shown on Drawings.

3. Material:

    a. Galvanized Steel at Door 002D: Nominal 0.028-inch- thick, hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653/A 653M.

    b. Aluminum at Door 021B: 0.040-inch- thick aluminum sheet complying with ASTM B 209, of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.

G. Electric Door Operator:

1. Usage Classification: Medium duty, up to 12 cycles per hour and up to 50 cycles per day.

    a. Operator Location(s): Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.

2. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use.

3. Motor: Reversible-type motor with controller (disconnect switch) for motor exposure indicated:

    a. Motor Exposure:

        1) Door 002D: Interior, dry.

        2) Door 021B: Interior, wet, and humid.

    b. Electrical Characteristics: See Electrical Drawings for electrical service.

    c. Motor Size: Large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.

4. Emergency Manual Operation: Chain type.

5. Obstruction Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.

    c. Automatic Photoelectric Sensor: Manufacturer’s standard system designed to detect an obstruction in door opening without contact between door and obstruction.

1) Exposure:

a) Door 002D: Dry.

b) Door 021b: Wet and humid.

6. Control Station(s), Mounting Location(s), and Exposure(s): Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."

c. Interior-Mounted Units, Dry Conditions - Door 002D: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure. Locate where shown on the Drawings.

d. Interior-Mounted Units, Wet and Humid Conditions - Door 021B: Full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated. Locate where shown on the Drawings.

H. Curtain Accessories: Equip door with the following:

1. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.

I. Door Finish:

1. Aluminum: Baked-enamel or powder-coated finish; color as indicated on Drawings.

2. Steel: Baked-enamel or powder-coated finish; color as indicated on Drawings.

J. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated.

B. Curtain Jamb Guides: Manufacturer’s standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.6 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

2.7 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.

C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.8 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.

2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Motors: As indicated for each door.

1. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.

2. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

D. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

E. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 30 lbf.

F. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

G. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

2.9 GENERAL FINISH REQUIREMENTS

C. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.10 ALUMINUM FINISHES

A. Clear Anodic Finish, Interior Doors - Door 137C: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

B. Baked-Enamel or Powder-Coat Finish - Door 021B: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

2.11 STEEL AND GALVANIZED-STEEL FINISHES

A. Baked-Enamel or Powder-Coat Finish - Door 002D: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

E. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

F. Power-Operated Doors: Install according to UL 325.

3.2 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.

C. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

D. Power-Operated Doors: Install according to UL 325.

3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Perform installation and startup checks according to manufacturer's written instructions.

2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3. Test door closing when activated by detector or alarm-connected fire release system. Reset door-closing mechanism after successful test.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide tight fit around entire perimeter.

3.5 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of coiling-door Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for door operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

   1. Perform maintenance, including emergency callback service, during normal working hours.

3.6 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train OWNER's personnel to operate overhead coiling doors.

B. Engage a factory-authorized service representative to train OWNER's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION

Division 09 – Finishes

SECTION 09 91 13

EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Surface preparation and the application of paint systems on the following exterior substrates.
2. Concrete.
    a. Non-traffic bearing surfaces.
3. Clay masonry.
4. Concrete masonry units (CMUs).
5. Steel and iron.
6. Galvanized metal.
7. Wood.
    a. Dressed lumber including doors, door and window frames, casings, battens, and smooth facias.
8. EXTERIOR PAINTING SCHEDULE

1.2 RELATED SECTIONS

Not Applicable

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. ASTM

1. D16 – Standard Terminology for Paint, Related Coatings, Materials, and Applications.
2. D4442 – Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.

C. SSPC

1. SP 1 – Solvent Cleaning.
2. SP 2 – Hand Tool Cleaning.
3. SP 3 – Power Tool Cleaning.
4. SP 6 – Commercial Blast Cleaning.

D. MPI – Master Painters Institute Architectural Painting Specification Manual

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product. Include preparation requirements and application instructions.
    a. Include printout of current “MPI Approved Products List” for each product category specified, with the proposed product highlighted.
    b. Indicate VOC content.
2. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
    a. Submit Samples on rigid backing, 8 inches square.
    b. Apply coats on Samples in steps to show each coat required for system.
    c. Label each coat of each Sample.
    d. Label each Sample for location and application area.
3. Certification that products meet specified standards.
4. Mock-ups as required.

1.5 QUALITY ASSURANCE

1. Applicator Qualifications: Minimum of 5 years’ experience in applying specified products and successful completion of at least three projects of similar scope and complexity.
2. Mock-Ups: Provide a 4x4 foot mock-up of each type of finish on each substrate for approval before proceeding with the full-scale application.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site in the original, unopened packages with manufacturer's labels intact.

B. Store materials in a dry, well-ventilated area at a temperature between 50°F (10°C) and 90°F (32°C).

C. Maintain containers in clean condition, free of foreign materials and residue.

D. Remove rags and waste from storage areas daily.

1.9 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. PPG Architectural Finishes, Inc.

2. Sherwin-Williams Company (The).

3. Tnemec.

4. Zinsser; Rust-Oleum Corporation.

B. Products (As Scheduled): Subject to compliance with requirements, provide products listed in the Exterior Painting Schedule at end of this Section. Products are listed (with some exceptions) by MPI number and shall be selected from the “MPI Approved Products Lists” (see https://www.mpi.net/APL/index.asp). Equivalent products not included in the “MPI Approved Products Lists” shall be submitted as substitution requests.

2.2 PAINT, GENERAL

A. MPI Standards: Unless indicated otherwise, products shall comply with MPI standards indicated and shall be listed in its “MPI Approved Products Lists,” except if approved by a substitution request.

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. VOC Content, General: For field applications, paints and coatings shall comply with VOC content limits of authorities having jurisdiction.

D. Colors: As indicated on Drawings Paint Schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.

2. Clay Masonry: 12 percent.

3. Concrete Masonry Units (CMUs): 12 percent.

4. Wood: 15 percent.

C. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Clay Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Concrete Masonry Unit (CMU) Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

G. Bare Steel Substrates: Remove rust, loose mill scale, and residual coatings if any. Clean using methods recommended in writing by paint manufacturer but not less than SSPC-SP 7/NACE No. 4, Brush-Off Blast Cleaning or SSPC-SP 11, Power Tool Cleaning to Bare Metal.

H. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 (Shop, Field, and Maintenance Painting of Steel) for touching up shop-primed surfaces.

I. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

J. Wood Substrates:

1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.

2. Sand surfaces that will be exposed to view; remove sanding dust.

3. Prime edges, ends, faces, undersides, and backsides of wood.

4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".

1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.

3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.

4. Paint entire exposed surface of window frames and sashes.

5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

D. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view:

a. Equipment, including panelboards and switch gear.

b. Uninsulated metal piping.

c. Uninsulated plastic piping.

d. Pipe hangers and supports.

e. Metal conduit.

f. Plastic conduit.

g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: OWNER may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. CONTRACTOR shall touch up and restore painted surfaces damaged by testing.

2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, CONTRACTOR shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

B. Conduct a final inspection with the Architect/Engineer to ensure compliance with specifications and project requirements.

C. Obtain final approval and acceptance of the painted surfaces.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by ENGINEER, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Non-traffic Bearing Surfaces:

1. Water-Based Light Industrial Coating System MPI EXT 3.1C:

a. Prime Coat: Primer, alkali resistant, water based, MPI #3.

b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated:

1) Light industrial coating, exterior, water based (MPI Gloss Level 3), MPI #161.

2) Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.

3) Light industrial coating, exterior, water based, gloss (MPI Gloss Level 6), MPI #164.

B. Clay Masonry Substrates:

1. Water-Based Light Industrial Coating System MPI EXT 4.1C:

a. Prime Coat: Primer, alkali resistant, water based, MPI #3.

b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated:

1) Light industrial coating, exterior, water based (MPI Gloss Level 3), MPI #161.

2) Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.

3) Light industrial coating, exterior, water based, gloss (MPI Gloss Level 6), MPI #164.

C. CMU Substrates:

1. Water-Based Light Industrial Coating System MPI EXT 4.2C:

a. Prime Coat: Block filler, latex, interior/exterior, MPI #4.

b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated:

1) Light industrial coating, exterior, water based (MPI Gloss Level 3), MPI #161.

2) Light industrial coating, exterior, water based (MPI Gloss Level 5), MPI #163.

3) Light industrial coating, exterior, water based (MPI Gloss Level 6), MPI #164.

D. Steel and Iron Substrates:

1. Water-Based Light Industrial Coating System MPI EXT 5.1B/C/M/N/R:

a. Prime Coat: One of the following:

1) Primer, zinc rich, inorganic, MPI #19 for 5.1B.

2) Primer, alkyd, anti-corrosive for metal, MPI #79 for 5.1C.

3) Primer, epoxy, water based, anti-corrosive, for metal, MPI #301 for 5.1M.

4) Primer, epoxy, anti-corrosive MPI #101 for 5.1N & 5.1R.

5) Shop primer specified in Section where substrate is specified.

b. Intermediate Coat:

1) For 5.1B: Light industrial coating, exterior, water based, matching topcoat. Apply where Premium Grade system is indicated.

2) For 5.1C/M/N: Light industrial coating, exterior, water based, matching topcoat. Application required.

3) For 5.1R: Epoxy, high build, low gloss MPI #108. Application required.

c. Topcoat: One of the following matching gloss levels indicated.

1) Light industrial coating, exterior, water based (MPI Gloss Level 3), MPI #161.

2) Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.

3) Light industrial coating, exterior, water based, gloss (MPI Gloss Level 6), MPI #164.

E. Galvanized-Metal Substrates:

1. Water-Based Light Industrial Coating System MPI EXT 5.3G/J/K:

a. Prime Coat: One of the following:

1) Primer, galvanized, cementitious, MPI #26 for 5.3G.

2) Primer, galvanized, water based, MPI #134 for 5.3J.

3) Primer, epoxy, anti-corrosive, MPI #101 for 5.3K.

4) Shop primer specified in Section where substrate is specified.

b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated:

1) Light industrial coating, exterior, water based (MPI Gloss Level 3), MPI #161.

2) Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.

3) Light industrial coating, exterior, water based, gloss (MPI Gloss Level 6), MPI #164.

F. Exposed Wood of Dressed Lumber: Includes doors, door and window frames, casings, battens, and smooth facias:

1. Water-Based Light Industrial Coating System MPI EXT 6.3J:

a. Prime Coat: Primer, alkyd for exterior wood, MPI #5.

b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated:

1) Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.

2) Light industrial coating, exterior, water based, gloss (MPI Gloss Level 6), MPI #164.

3.7 DOCUMENTATION

A. Submit product data sheets, color charts, and warranties to the Architect/Engineer.

B. Provide maintenance instructions and touch-up procedures for the owner’s use.

END OF SECTION

SECTION 09 91 23

INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Surface preparation and the application of paint systems on the following interior substrates.
    a. Concrete.
        1) Non-traffic bearing surfaces.
    b. Concrete Masonry Units (CMUs).
    c. Steel and Iron.
    d. Galvanized Metal.
    e. Wood.
        1) Dressed lumber including trim, architectural woodwork, doors, windows, and board paneling.
    f. Gypsum board.
    g. Cotton, canvas, and All Service Jacket (ASJ) insulation coverings.
2. See INTERIOR PAINTING SCHEDULE at end of Section.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.
2. Section 05 12 00 “Structural Steel Framing” for shop priming structural steel.
3. Section 05 50 00 “Metal Fabrications” for shop priming metal fabrications.
4. Section 05 51 13 “Metal Pan Stairs” for shop priming metal pan stairs.
5. Section 05 51 16 “Metal Floor Plate Stairs” for shop priming metal floor plate stairs.
6. Section 05 51 19 “Metal Grating Stairs” for shop priming metal grating stairs.
7. Section 05 52 13 “Pipe and Tube Railings” for shop priming pipe and tube railings.

1.2 RELATED SECTIONS

Not Applicable

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUBMITTALS

A. Not Applicable.

1.5 QUALITY ASSURANCE

A. Not Applicable.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. MPI Gloss Level 1 (Flat): Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 2 (Velvet-Like): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 3 (Eggshell-Like): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 4 (Satin-Like): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

E. MPI Gloss Level 5 (Semi-Gloss): 35 to 70 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 6 (Gloss): 70 to 85 units at 60 degrees, according to ASTM D523.

G. MPI Gloss Level 7 (High Gloss): More than 85 units at 60 degrees, according to ASTM D523.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.

2. Remove rags and waste from storage areas daily.

1.9 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. PPG Paints.

2. Sherwin-Williams Company (The).

3. Tnemec.

4. Zinsser; Rust-Oleum Corporation.

B. Products (As Scheduled): Subject to compliance with requirements provide products listed in the Interior Painting Schedule at the end of this Section. Products are listed (with some exceptions) by MPI number and shall be selected from the “MPI Approved Products Lists” (see www.mpi.net/APL/index.asp). Equivalent products not included in the “MPI Approved Products Lists” shall be submitted as substitution requests.

2.2 PAINT, GENERAL

A. MPI Standards: Unless indicated otherwise, products shall comply with MPI standards indicated and shall be listed in its “MPI Approved Products Lists,” except if approved by a substitution request.

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in a paint system and on substrate indicated.

C. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Non-Flat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

D. Colors: As indicated on Drawings Paint Schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Concrete Masonry Units (CMUs): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Concrete Masonry Unit (CMU) Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Bare Steel Substrates: Remove rust, loose mill scale, and residual coatings, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. Substrates Not Subject to Wetting by Condensation, Dampness, or Humidity: SSPC-SP 2, Hand Tool Cleaning or SSPC-SP 3, Power Tool Cleaning as required to achieve a clean surface.

2. Substrates Subject to Wetting by Condensation, Dampness, or Humidity: SSPC-SP 7/NACE No. 4, Brush-Off Blast Cleaning or SSPC-PC 11, Power Tool Cleaning to Bare Metal.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 (Shop, Field, and Maintenance Painting of Steel) for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.

2. Sand surfaces that will be exposed to view, and dust off.

3. Prime edges, ends, faces, undersides, and backsides of wood.

4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

J. Cotton, Canvas, or All Service Jacket (ASJ) Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and colorbreaks.

D. Painting Fire Suppression, plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Occupied Spaces: Paint the following work where exposed:

a. Equipment, including panelboards.

b. Uninsulated metal piping.

c. Uninsulated plastic piping.

d. Pipe hangers and supports.

e. Metal conduit.

f. Plastic conduit.

g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

h. Other items as directed by ENGINEER.

2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: OWNER may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. CONTRACTOR shall touch up and restore painted surfaces damaged by testing.

2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, CONTRACTOR shall pay for testing and apply additional as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by ENGINEER, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaces painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Non-traffic Surfaces.

1. High-Performance Architectural Latex System MPI INT 3.1C:

a. Prime Coat: Primer, alkali resistant, water based, MPI #3.

b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated.

1) Latex, interior, high performance architectural (MPI Gloss Level 2), MPI #138.

2) Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.

3) Latex, interior, high performance architectural (MPI Gloss Level 4), MPI #140.

4) Latex, interior, high performance architectural, semi-gloss (MPI Gloss Level 5), MPI #141.

B. CMU Substrates.

1. High-Performance Architectural Latex System MPI INT 4.2D/P:

a. Primer/Block Filler: One of the following:

1) Block filler, latex, interior/exterior, MPI #4 for 4.2D.

2) Primer, alkali resistant, water based, MPI #3 for 4.2P.

b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated.

1) Latex, interior, high performance architectural (MPI Gloss Level 2), MPI #138.

2) Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.

3) Latex, interior, high performance architectural (MPI Gloss Level 4), MPI #140.

4) Latex, interior, high performance architectural, semi-gloss (MPI Gloss Level 5), MPI #141.

C. Steel Substrates.

1. High-Performance Architectural Latex System MPI INT 5.1R/RR:

a. Prime Coat: One of the following:

1) Alkyd, quick dry, for metal, MPI #76 for 5.1R.

2) Alkyd, anti-corrosive, for metal, MPI #79 for 5.1RR.

3) Shop primer specified in Section where substrate is specified.

b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated.

1) Latex, interior, high performance architectural (MPI Gloss Level 2), MPI #138.

2) Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.

3) Latex, interior, high performance architectural (MPI Gloss Level 4), MPI #140.

4) Latex, interior, high performance architectural, semi-gloss (MPI Gloss Level 5), MPI #141.

2. Water-Based Dry-Fall System MPI INT 5.1C/CC/Z:

a. Prime Coat: One of the following:

1) Alkyd, quick dry, for metal, MPI #76 for 5.1C.

2) Alkyd, anti-corrosive, for metal, MPI #79 for 5.1CC.

3) Quick dry, for shop application, MPI #275 for 5.1Z.

4) Shop primer specified in Section where substrate is specified.

b. Topcoat: One of the following matching gloss levels indicated:

1) Dry fall, latex, flat, MPI #118.

2) Dry fall, water based, for galvanized steel, flat (MPI Gloss Level 1), MPI #133.

3) Dry fall, latex (MPI Gloss Level 3), MPI #155.

4) Dry fall, water based, for galvanized steel, (MPI Gloss Level 3), MPI #131.

5) Dry fall, latex (MPI Gloss Level 5), MPI #226.

6) Dry fall, water based, for galvanized steel, (MPI Gloss Level 5), MPI #158.

D. Galvanized-Metal Substrates.

1. High-Performance Architectural Latex System MPI INT 5.3M:

a. Prime-Coat: One of the following:

1) Primer, galvanized, water based, MPI #134.

2) Shop primer specified in Section where substrate is specified.

b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following gloss levels indicated:

1) Latex, interior, high performance architectural (MPI Gloss Level 2), MPI #138.

2) Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.

3) Latex, interior, high performance architectural (MPI Gloss Level 4), MPI #140.

4) Latex, interior, high performance architectural, semi-gloss (MPI Gloss Level 5), MPI #141.

2. Water-Based Dry-Fall System MPI INT 5.3H:

a. Prime Coat: One of the following:

1) Dry fall, water based, for galvanized steel, matching topcoat.

2) Shop primer specified in Section where substrate is specified.

b. Topcoat: One of the following matching gloss levels indicated:

1) Dry fall, water based, for galvanized steel, flat (MPI Gloss Level 1), MPI #133.

2) Dry fall, water based, for galvanized steel (MPI Gloss Level 3), MPI #131.

3) Dry fall, water based, for galvanized steel, semi-gloss (MPI Gloss level 5), MPI #158.

E. Exposed Wood of Dressed Lumber. Includes trim, architectural woodwork, doors, windows, and board paneling.

1. High-Performance Architectural Latex System MPI INT 6.3A:

a. Prime Coat: Primer, latex, for interior wood, MPI #39.

b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated:

1) Latex, interior, high performance architectural (MPI Gloss Level 2), MPI #138.

2) Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.

3) Latex, interior, high performance architectural (MPI Gloss Level 4), MPI #140.

4) Latex, interior, high performance architectural, semi-gloss (MPI Gloss Level 5), MPI #141.

F. Gypsum Board Substrates.

1. Latex System MPI INT 9.2A:

a. Prime Coat: One of the following:

1) Primer sealer, latex, interior, MPI #50. Apply where Premium Grade system is indicated.

2) Latex, interior, matching topcoat.

b. Intermediate Coat: Latex, interior, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated:

1) Latex, interior, flat (MPI Gloss Level 1), MPI #53.

2) Latex, interior (MPI Gloss Level 2), MPI #44.

3) Latex, interior (MPI Gloss Level 3), MPI #52.

4) Latex, interior (MPI Gloss Level 4), MPI #43.

5) Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.

6) Latex, interior, gloss (MPI Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.

2. High-Performance Architectural Latex System MPI INT 9.2B:

a. Prime Coat: Primer sealer, latex, interior, MPI #50.

b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated.

1) Latex, interior, high performance architectural (MPI Gloss Level 2), MPI #138.

2) Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.

3) Latex, interior, high performance architectural (MPI Gloss Level 4), MPI #140.

4) Latex, interior, high performance architectural, semi-gloss (MPI Gloss Level 5), MPI #141.

3. Wallcovering Primer: Mildew resistant formulation suitable for use with wallcovering and adhesive types furnished for Project. Tint to match background color of wallcovering:

a. Available products include, but are not limited to, the following:

1) Zinsser; Shieldz Universal Wallcovering Primer; 1 coat minimum.

2) Zinsser; Shieldz Clear Wall Size; 2 coats minimum.

G. Cotton, Canvas, and All Service Jacket (ASJ) Insulation Coverings. Includes pipe and duct coverings.

1. Latex System MPI INT 10.1A:

a. Prime Coat: One of the following:

1) Latex, interior, matching topcoat, except use following primer where Premium Grade system is indicated.

2) Primer sealer, latex, interior, MPI #50.

b. Intermediate Coat: Latex, interior, matching topcoat. Apply where Premium Grade system is indicated.

c. Topcoat: One of the following matching gloss levels indicated:

1) Latex, interior, flat (MPI Gloss Level 1), MPI #53.

2) Latex, interior (MPI Gloss Level 2), MPI #44.

3) Latex, interior (MPI Gloss Level 3), MPI #52.

4) Latex, interior (MPI Gloss Level 4), MPI #43.

5) Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.

6) Latex, interior, gloss (MPI Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.

3.7 DOCUMENTATION

A. Submit product data sheets, color charts, and warranties to the Architect/Engineer.

B. Provide maintenance instructions and touch-up procedures for the owner's use.

END OF SECTION

SECTION 09 96 53.13

ELASTOMERIC POLYUREA COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Surface preparation and application of polyurea elastomeric coatings, including primers, to the following interior substrates:

   a. Concrete.

   b. Concrete Unit Masonry.

   c. Steel.

   d. Substrates indicated on Drawings.

B. Section applies to the following:

1. Vehicle wash bay walls and vertical surfaces.

2. Vehicle wash bay floors and traffic bearing horizontal surfaces.

1.2 RELATED SECTIONS

Not Applicable

1.3 REFERENCES

A. ASTM – American Society for Testing and Materials.

1. ASTM C811 Standard Practice for Surface Preparation of Concrete for Application of Chemical-Resistant Resin Monolithic Surfacings.

2. ASTM D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.

3. ASTM D624 Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.

4. ASTM D638 Standard Test Method for Tensile Properties of Plastics.

5. ASTM D2240 Standard Test Method Rubber Property-Durometer Hardness.

6. ASTM D4060 Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.

7. ASTM D4263 Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

8. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.

9. ASTM F1869 Standard Test Method for Measuring Moisture Vapor Emission rate of Concrete Subfloor using Anhydrous Calcium Chloride.

10. ASTM F2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

B. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product. Include manufacturer's technical data, application instructions, and recommendations for each elastomeric polyurea coating component required, including primers.

2. Samples for Selection: For each type of exposed finish required, from manufacturer's standard color charts.

3. Samples for Verification: For each type of elastomeric polyurea coating indicated and in each color.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by coating manufacturer.

1. Engage an installer who is certified in writing by coating manufacturer as qualified to apply coating systems indicated.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Comply with coating manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting coating application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during coating application.

C. Close spaces to traffic during coating application and for 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain resinous coating materials, including primers, resins, and hardening agents, from single source from single manufacturer.

B. Products: Subject to compliance with requirements, provide one of the following:

1. Rhino Linings Industrial; Rhino eXtreme 11-50 FR.

2. SPI Specialty Products Inc.; Polyshield HT 100F or Polyshield HT 100F.

3. VersaFlex Inc.; FSS 50DM FR.

4. Or equal.

2.2 MATERIALS

A. Elastomeric Polyurea Coating: Abrasion-, impact-, and chemical-resistant, and 100 percent solids polyurea resin-based monolithic coating designed to produce a seamless wall, floor, or ceiling surface for the applications indicated.

1. Only two component coatings mixed using 1 part isocyanate and 1 part resin will be accepted.

B. Performance Requirements:

1. VOC Content: For field applications that are inside the weatherproofing system, coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

a. Flat Paints and Coatings: 50 g/L.

b. Non-flat Paints and Coatings: 50 g/L.

c. Primers, Sealers, and Undercoaters: 100 g/L.

d. Floor Coatings: 50 g/L.

2. Service Temperature: Coating shall maintain specified physical properties from minus 40 deg F to plus 250 deg F.

3. Flammability: Class 1 with flame spread of 25 or less and smoke developed of 450 or less according to ASTM E84.

C. System Characteristics:

1. Color: As selected by ENGINEER from manufacturer's full range of standard colors.

2. Wearing Surface: Orange-peel texture.

3. Overall System Thickness: Minimum 1/16 inch.

D. System Physical Properties: Provide coating system with the following minimum physical property requirements when tested according to test methods indicated:

1. Hardness: Not less than 35 Shore D according to ASTM D2240 as tested using coating thickness not less than 1/32 inch.

2. Tensile Strength: Either of the following:

a. Not less than 2200 psi per ASTM D412 as tested using 1/8 inch thick coating.

b. Not less than 2000 psi per ASTM D638 as tested using coating thickness not less than 1/32 inch and not greater than 1/16 inch.

3. Elongation:

a. Not less than 200 percent per ASTM D412 as tested using 1/8 inch thick coating.

b. Not less than 200 percent per ASTM D638 as tested using coating thickness not less than 1/32 inch and not greater than 1/16 inch.

4. Tear Resistance per ASTM D624:

a. Not less than 600 lb./lin. in. as tested using 1/8 inch thick coating.

b. Not less than 300 lb./lin. in. as tested using coating thickness not less than 1/32 inch and not greater than 1/16 inch.

5. Tabor Abrasion per ASTM D4060, 1000 g at 1000 Cycles: Either of the following:

a. Not greater than 250 mg weight loss using H-18 wheel.

b. Not greater than 11 mg weight loss using CS-17 wheel.

E. Primer: Coating manufacturer's recommended, factory-formulated, alkali-resistant primer compatible with substrate and other materials indicated.

1. Formulation: Epoxy or modified urethane.

F. Material Compatibility: Materials for use within coating system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with manufacturer's requirements for maximum moisture content, alkalinity, and other conditions affecting performance of work.

B. Concrete and Masonry Surfaces:

1. Begin coating only when moisture content of substrate is 12 percent or less when measured with an electronic moisture meter.

2. Begin coating no sooner than 28 days after substrate is constructed and is visually dry on both sides.

3. Verify that substrate is within the range of alkalinity recommended by manufacturer.

4. Prepare concrete floor surfaces as specified under Part 3 Article "Preparation."

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

B. Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, curing compounds, form release agents, and incompatible paints and encapsulants. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.

2. Perform cleaning and coating application so dust and other contaminants from cleaning process will not fall on wet, newly coated surfaces.

D. Concrete Floor Substrates: Provide sound concrete floor surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with floor coating.

1. Roughen concrete floor substrates as follows:

a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.

b. Comply with ASTM C811 requirements unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete according to coating manufacturer's written instructions.

3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.

b. Plastic Sheet Test: ASTM D4263. Proceed with application only after testing indicates absence of moisture in substrates.

c. Relative Humidity Test: Use in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

E. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.

F. Resinous Materials: Mix components and prepare materials according to coating manufacturer's written instructions.

3.3 APPLICATION

A. Apply components of elastomeric polyurea coating system according to manufacturer's written instructions to produce a uniform, monolithic, seamless wearing surface of thickness indicated.

1. Coordinate application of components to provide optimum adhesion of coating system to substrate, and optimum intercoat adhesion.

2. Coat surfaces behind movable items the same as similar exposed surfaces.

3. Use equipment and techniques best suited for substrate and type of material being applied.

    a. For elastomeric polyurea coating(s) use only spray equipment designed for 1 part isocyanate to 1 part resin mix ratio. Equipment designed for 1 part isocyanate to 2 parts resin mix ratio will not be accepted.

4. Multiple coats of elastomeric polyurea material may be applied as required to build coat to minimum thickness specified. Apply each coat separately according to manufacturer's written instructions.

5. Apply coating to produce surface films without spotting, holidays, laps, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

6. Cure coating components according to manufacturer's written instructions. Prevent contamination during application and curing processes.

B. Primer: Apply primer over prepared substrate at manufacturer's recommended spreading rate.

    1. Primer must be applied over concrete and masonry substrates.

C. Elastomeric Polyurea Coating Thickness: 1/16 inch.

3.4 FIELD QUALITY CONTROL

A. Material Sampling: OWNER may, at any time and any number of times during resinous flooring application, require material samples for testing for compliance with requirements.

    1. OWNER will engage and independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of CONTRACTOR.

    2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.

    3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

B. Field Testing and Inspection: OWNER reserves the right to engage the services of a qualified testing agency to verify installed thickness of elastomeric coatings.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by ENGINEER, and leave in an undamaged condition.

D. At completion of construction activities, touch up and restore damaged or defaced coated surfaces.

E. Floor Coatings: Protect floor coatings from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by coating manufacturer.

3.6 DOCUMENTATION

A. Submit product data sheets, color charts, and warranties to the Architect/Engineer.

B. Provide maintenance instructions and touch-up procedures for the owner’s use.

END OF SECTION

Division 10 – Specialties

SECTION 10 14 63

APPLIED FILM SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. General:

1. All work and materials shall be constructed in strict accordance with the latest version of the American Public Works Association (APWA) Manual of Standard Specifications, all applicable local building codes, the Americans with Disabilities Act (ADA), except where otherwise noted in this Specifications.

2. The CONTRACTOR shall be responsible for obtaining and complying with all permits and licenses required for the construction and completion of the project and shall perform all work in accordance with the requirements and conditions of all permits and approvals applicable to this project. The CONTRACTOR shall ensure that the necessary right-of-ways, easements, and/or permits are secured prior to construction.

3. Designs included as part of this package are intended as wayfinding signage additions at UTA transit facilities. Provide a consistent product across the UTA transit network.

4. Use consistent proposed method of construction, materials and finishes to ensure a common approach and consistent product.

5. Unless specified otherwise, provide all fabrications manufactured to a tolerance of +/- 0.125” with respect of parallel and square truth and in respect of the overall dimensions shown on the drawings.

6. The details and specifications have been developed to a stage of ‘design intent’ for finished signage. Foundations and supports shall meet the requirements specified herein. The manufacturer shall provide sign designs compatible with foundation and support details. In all cases the Sign CONTRACTOR is responsible for ensuring that the finished product is structurally sufficient for the service conditions, which would be reasonably expected. This includes any structural calculations as required.

B. Section Includes: Field applied, shop printed film signage for applications including the following:

1. Exterior building façade, see Drawing ____.

2. Note to Designer: Add drawing/plan sheet information.

3. Note to Designer: This is required for federally funded projects.

1.2 RELATED SECTIONS

01 60 01 - Buy America Requirements

1.3 REFERENCES

A. American Public Works Association (APWA) Manual of Standard Specifications.

1.4 SUBMITTALS

A. Submittals Manufacturer's Data: Submit the manufacturer's technical data and installation instructions for the type of sign required.

B. Samples: Submit samples of the color and finish of exposed materials and accessories required for specialty signs. The OWNER's review of samples will be for color and texture only, Compliance with all other requirements is the exclusive responsibility of the CONTRACTOR. When requested, full-size samples of sign materials shall be provided.

1. Submit samples for approval of the following materials and assemblies prior to proceeding with the work (minimum 12" x 12" plates)

a. Paint/Vinyl color #1 on aluminum and polycarbonate

Primary Color Blue – PMS 2945, 3M Vivid Blue

b. Paint/Vinyl color #2 on aluminum and polycarbonate

Primary Color Red – PMS 186 Red, 3M Cardinal Red

c. Paint/Vinyl color #3 on aluminum

Primary Color White: PMS White, 3M White

d. Paint/Vinyl color #4 on aluminum and polycarbonate

Primary Color Black: PMS White, 3M Black

e. Paint/Vinyl color #5 on aluminum

Cool Gray: PMS Cool Gray 2, 3M Light Gray

f. Paint/Vinyl color #6 on aluminum and polycarbonate

Dark Gray: PMS Cool Gray, 3M Office Gray

g. Paint/Vinyl color #7 on aluminum and polycarbonate

Green: PMS 360, 3M Apple Green

h. Paint/Vinyl color #8 on aluminum and polycarbonate

Purple: PMS Purple C, 3M Dark Magenta

i. Paint/Vinyl color #9 on aluminum

Medium Blue: PMS 7461, 3M Olympic Blue

j. Paint/Vinyl color #10 on aluminum and polycarbonate

Blue: PMS 298, 3M Peacock Blue

C. Shop Drawings: Submit to UTA shop drawings of all sign components, structural frame, materials, colors, fittings, parts, wiring, and installation procedures showing layout, jointing and mounting details: Drawings shall clearly show provisions for all performance functions described herein. Provide details and sections at full-size Differences from the Contract drawings and be clearly identified and brought to the OWNER's attention is writing.

D. Sign Face Patterns: Submit accurate full-size face drawings of each sign, accurately showing the relationship of all parts to each other, including the sign border, and a description of the method of executing the work. Obtain the OWNER's approval of all patterns before proceeding with the work part of the assembly.

1.5 QUALITY CONTROL

A. Manufacturer and installer Qualifications: The Manufacturer and installer shall be an established firm which is regularly engaged in the fabrication and installation of specialty signs. Manufacturer shall have 5 years minimum experience in designing and fabricating signage units of a type and size similar to those shown in the drawings. The company shall also submit a list of sizable installations provided over a period of at least five years.

B. Execution: CONTRACTOR shall be responsible for strength and stability of signage units. Shop drawings shall include complete description of number and strength of connections, hinges, etc.

C. Quality Assurance

1. Lettering: Whitney Semibold and Whitney Condensed Medium, sizes as indicated on Contract drawings or OWNER provided master art.

2. Special Graphics: OWNER will provide master art for reproduction of any special graphics, including logos and symbols.

3. Sign Graphics: All sign graphics are to be computer generated and cut. Hand redered and/or hand cut graphics are not acceptable.

4. Design Requirements: Comply with the Americans with Disabilities Act Accessibility Guidelines and all applicable local codes.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 VISUAL STANDARDS

A. The Sign CONTRACTOR is responsible for ensuring that all colors and finishes are compatible with materials or substrates to which they are to be applied, in respect of ageing, color fastness, light reflectance and physical and chemical properties, such that the performance when applied is at least equal to the performance standards quoted by the manufacturer of the color finishing material.

B. Visual elements, including self-colored materials, applied color finishes and graphics will not show symptoms or color fade, degradation, brittleness, or substrate interaction as a result of ageing and/or exposure to daylight, artificial light, climatic and local environmental conditions such that the colors change beyond the material manufacturer's projected tolerances within the defined period.

1.8 STORAGE AND HANDLING

A. Product Handling: Ensure that all signs are adequately protected from damage during fabrication and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE OF PRODUCTS

A. All finished components, materials, methods of construction and fixings are expected to have a minimum life expectancy of 15 years under normal circumstances. It will be the Sign CONTRACTOR's responsibility to ensure the finished works meet or exceed the specified life expectancy. Details of maintenance requirements necessary to meet this specification will be documented by the Sign CONTRACTOR and provided in the form of a maintenance manual.

B. All materials utilized to construct or finish these signage products will be appropriate to the environmental conditions of the surroundings. Consideration will be given not only to weather conditions and the possible corrosion it may cause, but also to issues of vandalism, health, and safety.

C. The Sign CONTRACTOR is responsible for ensuring that all components are fit for purpose. This includes, but is not limited to, structural engineering, installation fixing methods, compatibility with existing elements and any highway guidance where components are located adjacent to the highway.

D. All products and materials described in this specification, with exception of electrical components shall be covered by a full performance guarantee (parts and labor) for a period of 3 years and their structural integrity shall be under warranty for a period of 10 years. Where the original material supplier's warranty exceeds these periods then the material supplier's warranty shall apply. The warranty period shall commence from the date of installation sign off.

2.2 FOUNDATIONS

A. Reinforcing Steel: Uncoated carbon steel bars conforming to AASHTO M31 or ASTM A615.

B. Concrete: APWA Class 4000. Alternate acceptable concrete mix shall meet Utah Department of Transportation (UDOT) Class AA(AE) specifications.

C. Anchor Bolts: ASTM F1554, Grade 55 cast into foundation concrete.

2.3 FRAMING SYSTEMS

A. Structural Frame: The framework of all signs shall have sufficient strength and rigidity to support the weight and horizontal loads of the entire sign assembly, from mounting points located as indicated in the mounting detail drawings, without noticeable deformation due to deflection or warping of any part of the assembly. Provide insulation between dissimilar metals to prevent electrolysis. Separate aluminum from steel with suitable paint or galvanizing.

1. All items shall be fabricated to comply with wind loading and other requirements of the International Building Code and other applicable codes.

2. Pieces shall be true, square, and free from warping.

3. All steel work shall be hot-dip galvanized per ASTM A123 after fabrication to protect against corrosion.

2.4 SIGN CABINETS

A. Sign Cabinets, Cladding and Trim

1. Fabrication: Accomplish fabrication of all metal parts in a uniform manner with surfaces level, plumb, true, and free of rack. The cutting of any holes shall be made by mechanical equipment. All machined edges shall be sufficiently ground before coating.

    a. All joints and seams in the exposed cladding shall be precise and tight fitting with no light leaks. Paint any exposed edges not anodized to match the color of the fixture.

2. Aluminum: Provide aluminum sheet and extruded sections where specified to be used. Single full sheets are to be used for each sign face, there are to be no joints in sheet unless otherwise shown on drawings and approved by UTA. Folded corners of aluminum sheet material shall be fully closed and be made neatly without pinching or other visible defects. The corners shall be made secure against accidental lifting.

    a. Use aluminum sheeting with a minimum thickness of 0.125” for all signs to prevent buckling of sign due to expansion and contraction.

3. Fastenings: Rivets, hex head bolts, washers, and nuts shall be stainless steel. All exposed fastenings shall be painted to match adjacent aluminum faces. Review existing fasteners and match.

4. Accessibility: Provide easy access by the Utah Transit Authority maintenance crews for changing lamps and ballasts. Provide for easy removal and easy, accurate reinstallation of the sign components by maintenance crews.

5. Expansion/Contraction: Provide for expansion and contraction of the sign components, without bowing, warping, or exposure of light leaks, for a range of ambient temperatures from +100° to 0° F., taking into account the added temperature of the light sources.

6. Heat Dissipation: Provide means to adequately and safely dissipate heat from the ballast, ensuring that light leaks, moisture, or dust penetration do not result.

7. Joints: All vertical and horizontal joints in the sign faces shall be true, tight, and unnoticeable with respect to shadows, dark strips, light strips, gaps, or light leaks of adjacent sheets. Location and frequency of joints shall be only as noted on the drawings.

    a. Make provisions to ensure that joints will remain true and tight under conditions of expansion and contraction of the faces, and under conditions of reinstallation by maintenance crews.

8. Illumination: Space lamps and arrange so that the entire sign face has uniform light intensity.

9. Plastics: Acrylic sheet to be of a UV stabilized quality cast or extruded high impact type, approved by UTA to suit the application. Acrylic shall be non-glare.

10. Vinyl Graphics: All vinyl films shall be 3M HP Production Adhesive Vinyl, exterior grade cast vinyl, with a minimum external warranty of 8 years and must be compatible with the material and / or substrate to which they are applied. All vinyl shall be cut to projects graphic requirements and shall be non-glare.

11. Overlays: Provide anti-graffiti coating free from dirt and debris.

2.4 METAL LETTERING

A. Individual Metal Letters:

1. Shall be cut from stainless steel plate where unfinished letters are shown. Use Aluminum plate where painted finish is required.

2. Cut in the dimensions indicated on the drawings. The router bit shall not exceed 1/8” diameter; finish returns with hand file for smooth finish and clean corners. The letters shall be cut with 90° returns, straight lines, sharp corners and smooth radii.

3. The face shall be free of gouges, cuts, and other surface defects.

4. Mounting:

    a. Large letters shall be stud mounted, welded, or drilled and tapped. Welding marks shall be buffed out such that they are not visible in the finish.

b. Small letters too small to be stud mounted, may be mounted with high bond two-part epoxy over the back of 90% of the surface. Protect surface from seepage, no visible epoxy shall be allowed.

2.5 FINISHES

A. General

1. Provide edges and surfaces that are clean, neat and free from burrs and indentations.

2. Grind, buff or polish welded, brazed, or soldered joints on exposed surfaces.

3. Buckling or visible surface color variations in exposed material metal finishes is not allowed.

4. Remove sharp edges to a fine pencil round without excessive radiusing.

5. All visible joints in materials provide even, hairline joints unless noted otherwise and approved on shop drawings for specific functional or visual requirements.

6. Match color of sheets, extrusions, and heads of fastening in color finished work.

B. Powder Coating

1. All aluminum panels and aluminum display cases (non-sign surfaces) shall be powder coated. Industry practice shall be followed. Submit process and technique to UTA for approval.

2. Powder coating shall have a warranty period of 10 years against fade and chalking.

3. All powder coating finishes shall have a 60% gloss.

2.6 ELECTRICAL REQUIREMENTS

A. Electrical Work: All materials and equipment shall be new and approved by Underwriters Laboratories for the purpose used. Accomplish all work in accordance with all applicable electrical construction codes and electrical safety codes.

1. General: Obtain permits and pay fees required by governmental agencies having jurisdiction over the work. Arrange for inspections required during installation. Upon completion of the work, furnish satisfactory evidence that all work has been installed in accordance with codes.

a. Do all the cutting and patching required for installation of the work. Perform all cutting and patching carefully to prevent damage to the structure and work of other trades. All cutting and patching shall be done by mechanics skilled in the trade affected and subject to approval of the ENGINEER.

b. Promptly remove and dispose of all waste material and rubbish from the site. At completion of the work, clean all lighting fixtures and signs and check for satisfactory operation.

c. All materials and workmanship shall be guaranteed for a period of one year after acceptance. Repair or replace all failures or defects in materials or workmanship during this period without delay, at no expense to the OWNER, providing that in the judgment of the ENGINEER, such failures are not the result of misuse or abuse.

2. Sign Wiring: All sign wiring and installation shall conform to Article 600 of the National Electrical Code (NEC). Label the stubbed-up conduit with the appropriate load.

3. Fixtures: All fixtures and installation shall be Underwriters Laboratories – and Utah Electrical Code-approved.

PART 3 – EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Examine the substrates and conditions under which the exterior signs are to be installed.

3.2 INSTALLATION

A. Installation of signs shall be completed within 15 days of notice from UTA that sign installation may commence.

1. Install sign units and components at the locations shown or scheduled, securely mounted. Shims for leveling shall be stainless steel or aluminum to avoid rust staining.

2. Install level, plumb, and at the proper height. Cooperate with the other trades for installation of sign units to finish surfaces. Repair or replace damaged units as directed by the ENGINEER.

3.3 ADJUSTING AND CLEANING

A. Temporary Covers: Signs which are installed prior to their assigned function being open to public use shall be covered by the CONTRACTOR to conceal the face from view. Coverings shall be dark gray or black plastic, neatly affixed to the sign face with matching or concealed fasteners. When coverings are removed, clean the sign and treat plastic faces with antistatic solution.

END OF SECTION

Division 13 – Special Construction

SECTION 13 34 70

PREFABRICATED OPERATOR RESTROOMS

PART 1 - GENERAL

1.1 SUMMARY

A. Description: The work of this Section includes furnishing and installing a prefabricated building which contains two restrooms and a breakroom, in accordance with the Contract Documents.

1.2 SUBMITTALS

A. Product Data: Submit two copies of manufacturer's literature for all products furnished, describing products, installation procedures and maintenance instructions.

B. Deferred Submittal: Procure prefabricated building. Prepare, submit, and obtain approval of all deferred submittals for the project required by Owner and the appropriate state or local agency including, but not limited to, quality control plan, the building structure, electrical requirements, plumbing, and building pad and foundations.

C. Shop Drawings: For all components of prefabricated modular concrete building, include plans, elevations sections, details, and attachments to other work. Include the following:

1. Door and window shop drawings. Include the following:

a. Building code data, including allowable area, actual area, occupancy group, construction type, and occupancy load.

b. Structural design loads, including roof snow load, floor live load, wind load, and seismic load.

c. Elevations of each door or window type with opening dimensions.

d. Details of doors and windows, including vertical- and horizontal-edge details and metal thicknesses.

e. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

f. Locations of reinforcement and preparations for hardware.

g. Details of each different wall opening condition.

h. Details of anchorages, joints, field splices, and connections.

i. Details of accessories.

2. Wiring Diagrams: For power, signal, and control wiring.

3. Delegated-Design Submittal: For prefabricated modular concrete building assembly indicated to comply with performance requirements and design criteria, including analysis data and structural design calculations signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 QUALITY CONTROL

A. Conduct quality control in line with the requirements of the General Provisions, with any modifications noted in this document.

B. Obtain manufacturer's prefabricated concrete structure quality control plan and submit to Owner and appropriate state or local agency for review and approval.

C. Prior to transport from manufacturer's facility, obtain results from all quality reviews and inspections conducted during unit manufacturing process and submit to Owner and appropriate state or local agency for review and approval.

D. Engage an experienced installer (either as a direct employee or as a subcontractor) who has prefabricated concrete structure installations similar in material, design, and extent to that indicated for this Project and with a minimum of 3-year record of successful in-service performance.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver and handle modular structures in such a manner to prevent damage to products and finishes.

B. Contractor and Owner to jointly inspect modular structure(s) for damage upon delivery. To ensure that this is done, Contractor is to coordinate delivery date/time with Owner's Quality and Construction Inspection team. Any damage, anomalies, or other items of concern with the structure are to be noted, photographed, itemized, and included in a written report.

C. Protect components during storage and construction against rain, snow, or ground water.

1.5 PROJECT CONDITIONS

A. Pre-Installation Conference

1. Conduct pre-installation conference between Contractor's Superintendent, Subcontractor, concrete foreman, the installer of each component of the associated work, installers of other work requiring coordination with precast concrete unit work, and the Engineer before beginning prefabricated concrete building assemblies and associated work.

2. The material selections and procedures to be followed in performing the work to ensure compliance with the requirements specified.

3. Repeat conference if either the concrete foreman or Contractor's Superintendent

are replaced before completion of work of this Section.

B. Frozen Work

1. Frozen materials or materials mixed or coated with ice or frost are prohibited.

2. Remove and replace work damaged by frost or freezing at no cost to the Owner.

1.6 WARRANTY

A. Provide warranty in writing from prefabricated concrete building assembly manufacturer that warrants concrete products against defects in materials or workmanship. Repair or replace any part of the product that proves, upon manufacturer's inspections, to be defective in materials and /or workmanship. Finished goods installed in the building will be covered by the manufacturer:

1. Warranty Period: One (1) year from date of purchase.

B. Warranty Specific Conditions:

1. Follow operating procedures and maintenance instructions for installation.

2. Only authorized representatives of manufacturer must perform repairs or replacements to the products supplied by manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. The manufacturer supplying the requested precast concrete multi-flush restroom facility must meet the following:

1. Be ISO 9001 certified at the time of bid.

2. Manufacturing plant must be PCI certified at the time of bid.

3. Have not defaulted on any contract within the last five years.

4. Provide engineering drawings and calculations stamped and signed by an Engineer licensed to practice in the State of Utah prior to acceptance.

5. Be pre-approved prior to bidding.

6. Show four examples of precast concrete flush facilities produced, installed, and in use as an example of their ability to perform on this contract.

B. Building manufacturer to provide a 20-year warranty for the structure. Have not defaulted on any contract within the last five years.

C. Provide engineering drawings and calculations stamped and signed by an Engineer licensed to practice in the State of Utah prior to acceptance.

D. Current Prequalified Manufactures:

CXT, Incorporated
Spokane Industrial Park
3808 North Sullivan Road, Building 7
Spokane, WA 99216
Phone: 800-696-5766

Public Restroom Company
2587 Business Parkway
Minden, NV 89423
Phone: 888-888-2060

E. Precast Concrete Manufacturers:

1. Design Components: Provide components of Prefabricated Buildings as indicated herein, including doors, hardware, accessories, and lighting components or provide equivalent components, by other manufacturers, approved in writing before bid by Engineer and prefabricated building manufacturer.

2.2 MATERIALS

A. Concrete, Section 03 30 00.

B. Design the concrete mix according to ACI 211.1 and Section 03 30 00.

1. Provide concrete meeting 5,000 psi compressive strength and adhering to ASTM C-150.

2. Use coarse aggregates in the concrete mix that conform to ASTM C33 with coarse aggregate size #67.

3. Ensure air-entraining admixtures conform to ASTM C260 and water-reducing admixtures conform to ASTM C494, Type A.

4. If using Self Compacting Concrete (SCC), ensure it conforms to ASTM C1611.

C. Colored Concrete

1. Provide color additives conforming to ASTM C979. A 12”x12”x1”. Provide color sample for approval.

2. The following will contain colored concrete:

a. Toilet building roof panels

b. Building walls

c. Screen panels

3. Use same brand and type of color additive throughout the manufacturing process.

4. Weigh all ingredients and provide adequate mixing operation to ensure uniform dispersion of the color.

D. Cold Weather Concrete

1. Concrete, Section 03 30 04.

2. Place cold weather concrete in accordance with ACI 306.

3. Do not place concrete if ambient temperature is expected to be below 35 degrees F. during the curing period unless heat is readily available to maintain the surface temperature of the concrete at least 45 degrees F.

4. Do not use materials containing frost or lumps of frozen materials.

E. Hot Weather Concrete

F. Conform to requirements on Section 03 30 04. Do not exceed a concrete's temperature of 95 degrees F. at placement. When the ambient temperature reaches 90 degrees F. protect the concrete with moist covering.

G. Concrete Reinforcement

1. Concrete Reinforcing, Section 03 20 00.

2. Conform all reinforcing steel to ASTM A615 and all welded wire fabric to ASTM A185.

3. Use only new reinforcement that is free of dirt, oil, paint, grease, loose mill scale, and loose or thick rust when placed.

4. Follow ACI318 for details not shown on drawings or specified.

5. Center steel reinforcement in the cross-sectional area of the walls with at least 1 1/4” of cover on the underside of the floor.

6. Maintain a maximum allowable variation for center-center spacing of reinforcing steel at 1/2”.

7. Use full lengths of reinforcing steel whenever possible. For long runs requiring splices, alternate splices from opposite sides of the components for adjacent steel bars. Lap bars #4 or smaller a minimum of 12”. Lap bars larger than #4 a minimum of 24 bar diameters.

8. Bend reinforcing bars cold. Do not field bend bars partially embedded in concrete unless approved by the customer.

H. Sealers and Curing Compounds

1. Use colorless curing compounds, complying with ASTM C309, Type I or 1-D, if necessary.

2. Apply a clear water repellent penetrating sealer as a weatherproofing sealer for the exterior of the building.

I. Caulking, Grout, Adhesive and Sealer

1. Cementitious Grouting, Section 03 61 00

2. Caulking service temperatures from -40 to +194 degrees F

3. Caulk interior and exterior joints with a paintable polyurethane sealant.

4. Use a non-shrink type of grout and paint it to closely match the color of the surrounding concrete.

5. Cement base coating is formulated with a very fine aggregate system and is a built-in bonding agent.

J. Paint

1. Painting, Section 09 91 00

2. Meet Federal specifications or equivalent. Paints should contain no more than 0.009 percent by weight of lead.

3. Type of paints for toilets

a. Inside concrete surfaces

1) Apply a chemical-resistant urethane on interior floors, colored gray.

2) Use a modified acrylic, water repellent penetrating stain for interior walls and ceilings, colored white, followed by a clear acrylic anti-graffiti sealer.

b. Metal surfaces both inside and out

1) DTM ALKYD (Direct-to-Metal Alkyd Enamel): A single-component, rust-inhibitive, high-build coating by Sherwin-Williams, Benjamin Moore, Rust-Oleum, or approved equivalent.

c. Exterior concrete surfaces

1) Use clearer on exterior slab. Acceptable products include Ashford Formula by Curecrete Distribution, Inc., Euco Diamond Hard by Euclid Chemical Co, or approved equal.

2) Exterior walls and roof will be a water repellent penetrating stain in the same color as the walls or roof followed by a clear acrylic anti-graffiti sealer.

K. Grab bars

1. Equip the facility with grab bars 18", 42" and 48" in length and 1 1/2 inches in diameter, 18-gauge, type 304 stainless steel, and provide a 1-1/2 inch clearance. Each grab bar must be capable of withstanding a 300-pound top load.

L. Toilet Paper Dispenser

1. Construct the dispenser from 1/4 inch thick, type 304 stainless steel. The dispenser must hold three (3) standard rolls of toilet paper and its fastening system must withstand a 300-pound top load.

M. Steel Doors

1. Use flush panel doors that are 1-3/4 inches thick, made of a minimum 16-gauge galvanized steel, and painted on top with DTM ALKYD.

2. Provide door frames of either knockdown or welded type, single rabbet, using a minimum of 16-gauge prime coated steel. Paint the top with DTM ALKYD and ensure the width suits the wall thickness. Provide three (3) rubber door silencers on the latch side of the frame.

N. Door Hinges

1. Provide 3 door hinges per door with dull chrome plating 4-1/2"x4-1/2", adjustable tension, automatic-closing for each door.

O. Lockset

1. All exterior doors to pre-fabricated restroom building shall be equipped with electronic key entry.

2. Electronic key entry to meet Stone Security typical electrified strike door locking system, or approved equal. Contractor to provide and install all necessary equipment.

3. Electronic key entry shall be connected to fiber system.

4. Card Reader to be provided at each exterior door for entry.

5. Lever handle both inside and out.

6. U.S. 26D finish.

7. Contact UTA locksmith for hardware requirements.

8. End user key cores shall be keyed and installed by the UTA locksmith, unless otherwise specified.

9. “Construction phase” key core shall be furnished and installed by the General Contractor unless otherwise arranged with the UTA locksmith. Construction phase operating and control keys shall be furnished to the UTA locksmith upon installation of these “construction” key cores. Construction cores will be returned to the General Contractor when UTA cores are installed.

10. R.I. Merril (801-263-2700) in Salt Lake City, UT. is to be included in any lock hardware bidding process due to their extensive knowledge and experience with UTA key systems, hardware and usage.

11. Please contact the UTA locksmith with any lock/keying concerns: J.V. Swanson (801-243-1288).

P. Door Stop

1. Provide dome style door stop meeting ANSI 156.16.

Q. Double Coat Hook

1. Provide 304 stainless steel 16-gauge (1.5mm) coat hook, formed construction with a satin finish and have 3/16”x 7/8” nail in anchor. Upper hook will extend at least 2-1/2” inches from the wall. Lower hook will extend at least 1-1/4” from the wall.

R. Door Sweep

1. Door sweep will be provided at the bottom of door and will be an adjustable brush type.

S. Wall Vent

1. Provide crank operated wall vent allowing the unit to be opened or closed. Crank will be removable. Vent cover will be 14-gauge 304 stainless steel painted with DTM and anchored into the concrete wall with high strength anti-rust tap con fasteners. Provide insect screen for event. Cover to be recessed a minimum ¾” on exterior walls with a 45-degree bevel. Interior to be flush mounted. Wall vent will not protrude from the wall.

T. Signs

1. Signs to have raised pictograms, letters, and Braille to meet ADA.

2. All signs inset a minimum of ¾” into wall with 45-degree bevel.

3. All signs to be anchored into concrete with ¼” x ¾” concrete anchor nail.

U. Windows

1. Provide steel window frames.
2. Window glazing will be 3/16” thick translucent pebble finished mar-resistant Lexan.
3. Windows to have ¾” recess with 45-degree bevel.
4. Window frames to have vandal resistant fasteners.

V. Plumbing

1. All fixtures to meet ANSI A112.19.2.
2. Fixture types shall be stainless steel.
3. Waste and vent material will be ABS or PVC plastic and will be plumbed to meet Uniform Building Codes.
4. Water material will be copper tubing Type L, hard drawn. A gate valve will be provided at the inlet end of the water line. All water lines will be of a size to provide proper flushing action based on a nominal water pressure of 40 psi.
5. Conceal all plumbing in the service area.
6. Provide vitreous china toilet and mount it on the wall. It must have a siphon jet action and a back spud for connecting to a concealed flush valve. Install the toilet so that the top of the seat is 18 inches above the finished floor. Use a heavy-duty solid plastic seat with an open front. Include stainless steel fixtures. Equip the toilets with floor-mounted supports.
7. Flush valve will be concealed closet flush-o-meter constructed of rough brass. Furnish valve with integral vacuum breaker and wall mounted push button. Valve will be of a water saver type with a flow of 1.6 gallons per flush.
8. Lavatory will be vitreous china with back splashguard, front overflow opening, equipped with brass trap and drainpipe without stopper. Sink will be 20 inches wide x 18 inches front to back x 5 ¾" inches deep with ADA trap cover. Stainless steel fixtures may be used.
9. Water valve will be self-closing water set with indexed push button.
10. Urinals will be constructed of vitreous china, wall hung with siphon jet action. Urinal will have a back spud for a concealed flush valve connection and will be mounted with the lip no higher than 17 inches above the finished floor. Valve will be water saver .5 gallon flush. Stainless steel fixtures may be used.
11. Hose bib provided in the chase area.
12. Hammer arrester to be installed on water line.

13. Install a trap primer distribution unit.

14. 30 gallon electric hot water tank.

15. Main Shut off valve and drain.

W. Electrical

1. Electrical General Requirements, Section 26 05 00

2. All components to be UL listed.

3. All electrical wiring will be in conduit, surface mounted in the service area and concealed in the user compartments. All wire will be copper.

4. A 100 amp breaker panel required. Service 100 amp 120/240 volt single phase.

5. Interior lights will be wall mounted, vandal resistant, 15 watt LED Luminaire. Lights will be controlled by phot cell and controlled by bypass. Lights will be 2 bulb T8 4 foot wrap around lens fixtures with low temperature ballast, emergency battery pack and fluorescent night light.

6. Lighting in Mechanical Room will be a 4 ft 2 lamp LED Greenlighting, controlled by a single pole switch.

7. 3 exterior 35-watt High Pressure Sodium lights, polycarbonate vandal resistant.

8. 1 GFI outlet located next to the sink.

9. 2 restroom HVI certified exhaust fans with 270 CFM speed controlled (control in chase area).

10. The hand dryer will be an air compression type with remote motor unit. Push button switch located in cast nozzle housing with flexible hose connecting blower motor, housing, and nozzle. Power input 120VAC, 7A (non-heated air).

X. Stalls

1. Stall partition walls to be produced of 3-inch concrete. Stall doors to be solid HDPE, in matching white color.

Y. Miscellaneous Items

1. Water bottle filling station capable of filling up to 40 oz water bottles to be included in the breakroom (1 total).

2. Sanitary Napkin Disposal Receptacle to be included in each of the restrooms (2 total).

3. Paper Towel Dispensers to be included in each of the restrooms and in the breakroom (3 total).

Z. Climate Control

1. Equip each room within the prefabricated building with a multi-zone wall-mounted type indoor unit heat pump. The heat pump must have a capacity of 7000 BTU/H.

AA. Rain Gutters and Downspouts

1. 24-gage steel gutters and downspouts attached to fascia of concrete eave:
    a. Finish: Bonderized/Paint Grip G40 per ASTM 653
    b. Finish Coating: Polyester interior and exterior
    c. Color: match color of exterior building paint
2. Attachment to modular concrete building fascia:
    a. Wej-Con Concrete Screws www.wejit.com
        1) High-strength, case-hardened screw with twin-lead, v-notched threads for anchoring into concrete.
        2) Slotted Hex washer head.
        3) Gimlet point.
        4) Blue Materials: Anchor Body: Heat treated C1022 carbon steel Heat Treatment: HRC 52 min. with core hardness of HRC 32 – 40 max. Finish: Blue R-Blocker coating, which provides 1000+ hours of salt spray resistance per ASTM B117.
    b. Approved equivalent.
3. Sealant: Seal top edge of gutter continuously to concrete fascia of eave.
    a. DOWSIL 790 Silicone Building Sealant, manufactured by The Dow Chemical Company.
        1) Conforming to ASTM C 920, Type S, Class100/50, Use T, NT, M, G, A and O.
        2) Conforming to ASTM C 719 – Joint Movement Capabilities of +100%/-50% according to ASTM Standard Extension/Compression.
        3) Color: Gray.
    b. Sikasil WS 290, manufactured by Sika Corporation.
        1) Approved Equivalent.

2.3 DESIGN AND FABRICATION

A. The prefabricated modular concrete building must match the dimensions and specifications detailed in the construction drawings. The structure will include 2 restrooms and 1 breakroom. The Santiago Building Number 22-019-3P, produced by CXT, has been designed to individually meet the following criteria. An approved equal prefabricated building meeting the criteria outlined in this special provision may be used if approved by the Engineer. Calculations and Engineer's stamped drawings must be submitted. The design criteria are to ensure the approved prefabricated structure, not only will withstand the forces of nature listed below but will provide protection from vandalism and other unforeseen hazards. Design criteria includes 2006 IBC Code, 2006 IPC, 2008 NEC, and Utah Building Code.

B. Roof Snow Load

1. Design the prefabricated restroom to support a snow load of 250 pounds per square foot.

C. Floor Load

1. Design the prefabricated restroom to support a floor load of 400 pounds per square foot.

D. Wind Load

1. Design to withstand the effects of 150 mile per hour (3-second gust) wind exposure C.

E. Earthquake

1. Design to withstand the effects of a seismic group 1 seismic design category E earthquake.

F. Additional Design Standards

1. Design to meet the requirements of the Americans with Disabilities Act Requirements and Uniform Federal Accessibility Standards as of the date of this specification.

2. Provide all-concrete structures with a minimum 3/12 roof pitch.

3. Provide minimum 4-inch wall, 4 ½ inch roof, and 5-inch floor thickness.

4. Ensure all interior surface seams where the wall meets the floor have a minimum 1-inch radius coving, made from high strength grout.

G. Provide building structure design and fabrication adequate to withstand wind loads, snow loads, and seismic activity for the geographic region in which it will be installed and in accordance with governing building codes and the stresses and shocks common to buildings. Clearly state in design calculations and Shop Drawings design loads and criteria, safety factors, etc. used to arrive at a design load.

H. Construct forms for precast components with finished components that have sharp definition, dimensional accuracy, and uniformity of shape and texture.

1. Prefabricate precast components to sizes and shapes indicated on plans.

2. Provide assembly with no unfinished edges exposed to view.

3. Provide finished components that are straight and square.

4. Do not use waxed, cracked, broken, spalled, stained, or otherwise defective units.

5. Do not use components with imperfections in exposed surfaces.

I. Prefabricate reinforcing assemblies into single complete units with minimum of 3/4 inch clearance from edges and surfaces of precast unit. Place and secure in forms all necessary anchors, clips, inserts, lifting devices, stud bolts, ties and other devices required for handling and installing precast components and for attachment of subsequent items.

J. Cure precast concrete components in forms for minimum of 24 hours, or until concrete reaches 75 percent of design strength.

1. Cover exposed surfaces to control the loss of moisture and temperature. After the precast component is removed from the form, cover it or moisture cure it until the results of a 7 day compression test is available.

K. Securely attach precast cover panels to walls to create a continuous unit. Firmly connect wall and floor reinforcing to each other. A professional engineer must approve the welding procedure.

L. Only use welders with current valid certifications and recent experience in this type of welding. Follow the American Welding Society Codes and Recommendations for all construction activities. Apply paint to all exposed steel plate assemblies, both inside and outside, over the shop coat.

M. Install a finished floor that is level along all walls. Ensure that no part of the floor allows wastewater to accumulate.

2.4 MANUFACTURE

A. Mixing and Delivery of Concrete

1. Mixing and delivery of concrete will be in accordance with ASTM C94, section 10.6 through 10.9 with the following additions:

a. Aggregate and water will be adjusted to compensate for differences in the saturated surface-dry condition.

B. Placing and Consolidating Concrete

1. Consolidate concrete using mechanical vibrators.

2. Ensure the vibration is sufficient to accomplish compaction but not to the point that segregation occurs.

C. Finishing Concrete

1. Interior floor and exterior slabs will be floated and troweled.

2. All exterior building walls and exterior screen walls will be any one of the available textures.

3. All exterior surfaces of the roof panels will be cast to simulate any one of the available textures. The underside of the overhang will have a smooth finish.

D. Cracks and Patching

1. Cracks in concrete components which are judged to affect the structural integrity of the building will be rejected.

2. Small holes, depressions and air voids will be patched with a suitable material. The patch will match the finish and texture of the surrounding surface.

3. Patching will not be allowed on defective areas if the structural integrity of the building is affected.

E. Curing and Hardening Concrete

1. Concrete surfaces will not be allowed to dry out from exposure to hot, dry weather during initial curing period.

2.5 FINISHING AND FABRICATION

A. Structural Joints

1. Join wall components together using two welded plate pairs at each joint. Place a 6-inch-long weld plate in both the top and bottom quarters of the seam. Anchor weld plates into the concrete panel and join them with a continuous weld. Use paintable caulk for inside seams and caulk in a coordinating building color or clear for outside seams.

2. Connect walls and roof using 3"x6" weld plates at each building corner.

3. Join the joint between the floor slab and walls with a grout mixture inside, a matching-colored caulk outside, and two 6-inch-long weld plates per wall.

B. Painting/Staining

1. Allow concrete to cure properly before applying paint.

2. Use a 30% hydrochloric acid solution for acid etching when needed, followed by a water flush and thorough air drying.

3. Avoid painting outside in cold, frosty, or damp weather.
4. Only paint outside in winter if the temperature is at least 50 degrees F.
5. Do not paint in dusty areas.
6. Fill all surface voids before painting.
7. Schedule of finishes
    a. Inside concrete surfaces
        1) Coat inside floors with 1 coat of 1-part water based chemical resistant urethane.
        2) Coat interior walls and ceilings with 2 coats of a modified acrylic, water repellent penetrating stain, followed by 1 coat of clear sealer.
    b. Metal surfaces both inside and out.
        1) 2 coats of Direct-to-Metal Alkyd Enamel (DTM ALKYD) by Sherwin Williams, Benjamin Moore, Rust-Oleum, or approved equal, applied per manufacturer's recommendations.
    c. Exterior concrete surfaces
        1) Coat exterior walls with 2 coats of water repellent penetrating sealer, PENTREAT 244-100 by W.R. Meadow, Concrete Protector WB by PROSOCO, Conformal Stain WB – Series 617 by Tnemec, or approved equal, in the same color as the walls or roof followed by 1 coat of clear acrylic anti-graffiti sealer.
    d. Exterior Doors and Frames:
        1) Prime and apply 2 coats of Urethane Alkyd Enamel. Color to be selected and approved by Engineer.

C. Caulking Compound: Before all joints of the package plant are sealed, place rolled polyurethane foam rope in seams. Seal joints with non-sag, non-staining polyurethane caulking compound meeting ASTM C-920-79. Sika-flex or equal is approved.

D. Gutters, Flashing, Downspouts, and Accessories: Fabricate in longest practical lengths.

E. Interior Walls, Ceiling, and Floor: Steel towel floor slab and provide broom finish. Apply floor sealer to finished concrete, Benjamin Moore Super Spec Waterborne Epoxy or approved equivalent. Seal interior walls and ceiling with Benjamin Moore Super Spec Acrylic Epoxy (or approved equal) tinted to Owner's specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Scope of Work

1. Work specified under this Section relates to the placement of the prefabricated unit on the prepared foundations.

B. Location

1. Provide exact location by stakes or other approved method.

2. Provide clear and level site free of overhead and/or underground obstructions.

3. Provide access to the site for truck delivery and sufficient area for the crane to install and the equipment to perform the contract requirements.

4. Water, electrical, and sewage site connections to be placed per engineered drawings. Must be placed to easily connect to the building.

C. Compacting

1. The bottom of the area must be compacted after it has been dug out. After the base has been placed, it must be compacted as well. The bearing of the soil and base should be a minimum of 1,500 pounds per square foot.

D. Base

1. After compacting the bottom of the excavated area, a minimum of 6” of a compacted, ¾” minus material base of gravel (i.e. road base) should be placed for support, leveling and drainage purposes. The base also limits frost action. The base must be confined so as to prevent washout, erosion or any other undermining.

E. Access to Site

1. Contractor is responsible for the delivery of the prefabricated structure to the site. Contractor is responsible for the placement of the prefabricated structure on the site. Delivery to site made on normal highway trucks and trailers.

F. Install as per each manufacturer's written instructions. Provide all necessary ground improvements including base material, compaction and concrete as required by prefabricated building manufacturer.

G. Gutters, Flashing, Downspouts, and Accessories

1. Comply with manufacturer’s instructions for assembly and installation.

2. Install in accordance with approved shop drawings.

3. Secure gutters and downspouts without warp or deflection.

4. Secure gutters true, with a slope down to downspout of 1” per 32’ run.

5. Secure downspout plumb, with a maximum variation of 1/4” in 10 vertical feet and

in accordance with SMACNA's "Architectural Sheet Metal Manual".

6. Connections and fittings shall be snug and watertight.

7. All downspout elbows shall be seamed.

8. Attachment:

    a. Fasten gutter flange support directly to center of concrete fascia of eave with 3/16"-diameter self-lagging screws installed in pre-drilled hole at maximum 18" on center and no more than 6" from each gutter end.

    b. Fasten downspout brackets directly to center of concrete wall with 3/16"-diameter self-lagging screws installed in pre-drilled hole each side of downspout.

    c. Installation of self-drilling screws: Follow screw manufacturer's written instructions.

        1) Use the correct size masonry drill bit and drill the hole at least 1/4" deeper than the calculated embedment depth for a minimum of 1" and a maximum of 1-3/4" embedment per fastener manufacturer's written instructions.

        2) Clean the hole using a nylon brush and compressed air.

        3) Place the anchor point through the gutter flange into hole.

        4) Drive the anchor in a single continuous motion until the anchor is set firmly against the gutter flange.

    d. Install gutter and downspout in compliance with Manufacturer's installation written instructions and the Engineer approved Shop Drawings.

    e. Install gutter to allow for thermal movement.

    f. Cutting and Fitting: Neat, square, and true. Torch or saw cutting is prohibited.

9. Sealant Application:

    a. Coat surfaces specified, scheduled, illustrated, and otherwise identified unless specifically noted otherwise.

    b. Apply sealants of type and color specified.

    c. Apply products in accordance with manufacturer's instructions. Use application materials, equipment, and techniques as instructed by sealant manufacturer and best suited for substrate and type of material being applied.

10. Field Quality Control:

a. Immediately prior to Substantial Completion, perform detailed inspection of gutters and downspouts and repair or refinish abraded, stained, and otherwise disfigured surfaces.

11. Cleaning:

a. Promptly remove spilled, splashed, and spattered gutters, flashing, downspouts and accessories. Clean spots, oil, and other soiling from finished surfaces using cleaning agents and methods which will not damage materials.

b. If completed construction is damaged beyond normal cleaning and repair by coating operations, replace damaged items at no additional cost to Owner.

c. Maintain premises and storage areas free of unnecessary accumulation of tools, equipment, surplus materials, and debris including fasteners, cuttings, filings and scraps.

d. Collect waste, cloths, and material which may constitute fire hazards and place in closed metal containers; remove from site daily along with empty containers.

12. Protection:

a. Protect work of other trades against damage from coating activities. Correct damage by cleaning, repairing, replacing, and recoating as acceptable to Engineer.

3.2 TESTING

A. Perform the following tests on concrete used in the manufacture of toilet facilities. Conduct all testing in PCI certified laboratories by qualified individuals certified as ACI Technician Grade 1. Follow ASTM C172 for sampling.

1. Check the air content of the first batch of concrete per ASTM C231. The air content must fall within the range of 5.0% to 7.0%.

2. Test the compressive strength of the cylinders according to ASTM C39. Make one (1) cylinder for release, one (1) for 7-days, and one (1) for 28-days. The release cylinder must achieve a minimum strength of 2500 psi, the 7-day a minimum of 3350 psi, and the 28-day a minimum of 5000 psi.

3. Make all test reports available to the customer as soon as the 28-day test results are ready.

END OF SECTION

Division 22 – Plumbing

SECTION 22 05 33

HEAT TRACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, drains and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:

   a. Self-regulating, parallel resistance.

2. The CONTRACTOR shall furnish and install complete and functional heat trace systems including wiring; controls; thermostats; all electrical connections and any conduit, cable, boxes, outlets and other equipment and accessories required.

1.2 RELATED SECTIONS

A. 26 05 26 – Grounding and Bonding for Electrical Systems

B. 26 05 19 – Low-Voltage Electrical Power Conductors and Cable

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

3. Thermostat, controls, warning lights, alarms, and control panels.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.

2. Include diagrams for power, signal, and control wiring.

3. Layout of wiring, controls, and all other equipment.

4. Calculation data showing the electrical load data for each system.

5. Installation instructions for the system.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

E. Operation and Maintenance Data: For electric heating cables to be included in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Manufacturer with at least five years of experience in producing heat tracing systems.

B. B. Installer Qualifications:

1. Licensed electrical contractors with experience in installing heat tracing systems.

C. C. Regulatory Requirements:

1. Comply with NFPA 70 and local electrical codes.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall furnish all necessary labor and tools, materials, and equipment and shall properly construct and connect the electric heat trace system in accordance with the manufacturer’s directions and recommendations.

B. The electric heat trace cable shall be either covered with a protective nickel braid or covered with a tinned copper braid and a corrosion protective outer fluoropolymer jacket; unless indicated otherwise.

C. The CONTRACTOR shall coordinate the design and installation of the heat trace system with the pipe insulation system.

D. The design, selection and size of the heat trace cable shall be in accordance with correct heat transfer calculations as recommended by the equipment manufacturer's design guide.

E. The system shall be controlled and monitored from a single control panel. The system shall be controlled from a thermostat with provisions for a manual override from a Hand-Off-Auto switch.

F. Monitoring and alarm circuits shall be provided that monitor each heat trace circuit for current and continuity of the heat trace cable, and the entire system for low temperature failure.

G. The electric heat trace cable, control panel, and accessories shall have UL, FM, or CSA system listing.

2.2 MATERIALS

A. The CONTRACTOR shall furnish and install the electric heat trace system which shall include but not be limited to the electric heat trace cable, tape or banding, thermostats, control panel and warning lights and alarm.

B. The electric heat trace system for freeze protection shall be controlled from a common ambient sensing thermostat set to activate the system at 40 degrees, and a parallel backup thermostat set at 40 degrees F. An alarm shall be provided to indicate the failure of either thermostat or lack of power.

C. The control panel shall provide the necessary controls and contactors plus an additional 25 percent spare space. The contactors shall be electrically operated, electrically held, 30 ampere, 600 Volt, 3 pole, with a 120 Volt control coil. The contactors shall be as manufactured by Allen Bradley, Square D or an approved equal.

D. LED pilot lights shall be provided to indicate control power available, system on, off, and circuit on and failure alarms for each heat trace circuit.

E. The system and all components shall be approved by the UTA.

F. The cable shall be industrial type, rated 8 watts per foot (W/ft), at 120 Volts, at a temperature 50 degrees F, and a temperature identification number (T-rating) of T6 (185 degrees F exposure). Values shall be established per Institute of Electrical and Electronics Engineers, Incorporated (IEEE) Standard 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.

G. The heating cable shall be self-regulating. The cable heat output shall decrease with raising ambient temperature without employment of an auxiliary electrical regulatory device.

H. The heating cable shall be composed of two parallel 16 AWG (or larger) stranded, nickel-plated copper bus wires, embedded in a polymeric conductive (heat generative) core (web). The wires and core shall be enclosed within a tinned copper, braided shield, suitable for use as an electrical fault grounding conductor. All cable components shall be jacketed with a tough, abrasion and moisture resistant thermoplastic (e.g., polyolefin), inert with aqueous and cleaning chemicals. The over-jacket shall provide corrosion protection for the cable. A polyolefin or fluoropolymer over-jacket is an acceptable alternate.

I. The cable shall have monitor wires and a tinned copper braid, with a fluoropolymer jacket for mechanical and corrosion protection. The cable is suitable for direct placement on metallic and polyvinyl chloride (PVC) piping. The heat trace circuits shall be designed to operate on 20 ampere circuits.

J. The heating cable shall be unaffected by exposure to non-hazardous, unshielded indoor and outdoor environmental conditions. The cable service life shall not be diminished by exposure to ultraviolet radiation and random fluctuating temperatures within a range of -30 degrees to 150 degrees F.

K. The cable shall have a minimum expected service lie of 10 years in applications of continuous operation. A minimum of 90% of the nominal rated power shall be exhibited following 1000 hours of continuous operation, in accordance with Underwriters Laboratories, Incorporated (UL) Standard 746B, Polymeric Materials – Long Term Property Evaluations.

L. The heating cable shall be UL approved. Cable shall have original manufacturer's labeling.

M. The heat trace system shall be manufactured by Delta-Therm, Chemelex, Bylin or approved equal.

2.3 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Raychem; a division of Tyco Thermal Controls.

2. Preapproved equivalent.

B. Comply with IEEE 515.1

C. Heating Element: Pair of parallel No. 16 (or larger) nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Capacities and Characteristics:

1. Maximum Heat Output: 8W/ft.

2.4 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.

2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

4. Corrosion-resistant, waterproof control enclosure.

B. Precipitation and Temperature Sensor for Snow Melting on Roofs and in Gutters:

1. Microprocessor-based or Automatic control with manual on, automatic, and standby/reset switch.

2. Precipitation and temperature sensors shall sense the surface conditions of roof and gutters and shall be programmed to energize the cable as follows:

a. Temperature Span: 34 to 44 deg F.

b. Adjustable Delay-Off Span: 30 to 90 minutes.

c. Energize Cables: Following two-minute delay if ambient temperature is below set point and precipitation is detected.

d. De-Energize Cables: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.

4. Minimum 30-A contactor to energize cable or close other contactors.

5. Precipitation sensor shall be freestanding.

6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

2.5 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Tape: Continuously printed “Electrical Tracing”; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for markers on pipes with OD, including insulation, less than 6 inches: 3/4 inch minimum.

2. Width for markers on pipes with OD, including insulation, 6 inches or larger: 1-1/2 minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

2. Heat tracing shall be installed on clean surfaces free of dirt, debris, protrusions, oil, grease, and moisture. Remove existing insulation, if any, as required for proper installation of the heat trace cable. Remove existing heat trace system or components as required for installation of the new system or components.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Locations for installation of the control panel, thermostat and warning light and alarm shall be approved by the UTA.

3.2 INSTALLATION - GENERAL

A. The heat trace cable shall be installed in such a manner as to maintain the best possible contact with the traced pipe, valves, flanges and other in-line equipment. The heat tracing cable shall be secured to the pipe as recommended by the heat trace system manufacturers installation instructions.

B. In order to allow for maintenance access to valves, strainers, and other in-line equipment where additional heat tracing is required, a loose loop of heating cable of the length required shall be left at the item to be traced. The loop shall be spiraled around the item and secured as recommended by the heat tracing system manufacturer’s installation instructions.

C. All junction boxes, splices, and terminations requiring maintenance shall be mounted to be accessible without disturbing the insulation and jacket.

D. The location of the ambient sensing thermostats shall be selected to obtain a representative temperature, be accessible for maintenance, and protected from tampering.

E. The installation and final adjustments to the electrical heat tracing system shall be supervised and field tested by a qualified factory trained equipment manufacturers service engineer.

F. After field testing has been completed the installed heat trace system shall be covered with insulation and a jacket as specified in pipe insulation section of this Specification.

G. All pipe electrically heat traced and insulated shall have a plastic label applied to the insulation every 25 feet. The plastic label shall read “Electric Heat Trace Circuit Number, Panel Number”.

H. Unless otherwise approved, cable of 1000 feet in length and shorter shall be furnished in one piece. Cable of greater lengths shall be furnished in increments of this length or longer.

3.3 INSTALLATION OF HEATING CABLE

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer’s written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Snow and Ice Melting on Roofs and in Gutters and Downspouts: Install on roof and in gutters and downspouts with clips furnished by manufacturer that are compatible with roof, gutters, and downspouts.

C. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.

2. Install electric heating cables according to IEEE 515.1.

3. Install insulation over piping with electric cables.

4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

D. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

A. Ground equipment according to Section 26 05 26 Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables.

3.5 ELECTRICAL CONNECTIONS

A. Final electrical connections between the heat trace system and the power source and the energizing of the system will be performed by the UTA's electrical department unless directed and approved otherwise.

3.6 RE-INSULATION

A. Re-insulate or insulate over the new heat trace cable after installation. See insulation specification. Type of insulation must be approved to be used with the heat trace cable to avoid fire and other hazards. Insulate according to manufacturer's directions. Take precautions to not damage the heat trace cable.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

2. Test cables for electrical continuity and insulation integrity before energizing.

3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 PROTECTION

A. Protect installed heating cables, including non-heating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

3.9 OPERATION AND MAINTENANCE MANUAL

A. Upon completion, CONTRACTOR shall test system for proper operation and set controls.

B. The equipment manufacturer and installer shall provide adequate training for the UTA's Personnel in the proper operation and maintenance of the equipment.

C. The installer shall provide as built drawings indicating the location of heat tracing and location of connections, controls, thermostats and warning lights and alarms. The manufacturer shall provide final and complete operation and maintenance manuals for all components of the heat trace system.

END OF SECTION

SECTION 22 11 13

FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Installation of building water piping, drain piping, and related work.
2. Installation of pipe hangers, sleeves, supports, brackets, and related items.
3. Testing of piping systems and correction of any problems found to exist.

1.2 RELATED SECTIONS

01 25 00 – Substitution Procedures

33 05 09 – Steel Pipe – Lined and Coated

33 05 05 – Ductile Iron Pipe

33 05 03 – Copper Pipe

33 05 07 – Polyvinyl Pipe

33 05 01 – Acrylonitrile Butadiene Styrene

33 05 11 – Polypropylene Pipe

33 13 00 – Disinfection

33 08 00 – Commissioning of Water Utilities

1.3 REFERENCES

A. ASME Standards:

1. B31.1: Power Piping.

1.4 SUBMITTALS

A. Product Data:

1. Manufacturer’s technical data for each type of pipe, fitting, valve, and accessory.
2. Installation instructions.
3. Operation and maintenance manuals.

B. Shop Drawings:

1. Piping layout drawings.

2. Details of pipe supports and hangers.

3. Connection details.

C. Samples:

1. Pipe and fitting samples as requested.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Manufacturer with at least five years of experience in producing piping systems.

B. Installer Qualifications:

1. Licensed plumbing contractors with experience in installing water distribution piping systems.

C. Regulatory Requirements:

1. Comply with IPC, UPC, and local plumbing codes

1.6 ACCEPTANCE

A. Not Applicable.

1.7 PIPING SYSTEM LAYOUTS

A. Piping system Drawings are diagrammatic and are intended to show approximate location of equipment and piping. Verify dimensions, whether in figures or scaled, in the field. The CONTRACTOR is responsible for the installation of complete and workable systems whether completely detailed on the plans or not.

B. Ascertain locations of apparatus, fixtures, equipment, and piping in the field, and layout work accordingly. The ENGINEER reserves the right to make minor changes in location of piping and equipment up to the time of installation without additional cost to the OWNER.

1.8 REQUIREMENTS OF REGULATORY AGENCIES

A. Install work per applicable provisions of codes, rules, regulations, statutes, and ordinances of authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PIPE

A. Provide size, type, and class of pipe for various uses as follows:

1. Steel pipelined and coated, Section 33 05 09.
2. Ductile iron pipe, Section 33 05 05.
3. Copper pipe, Section 33 05 03.
4. PVC pipe, Section 33 05 07.
5. ABS pipe, Section 33 05 01.
6. PP pipe, Section 33 05 11.

B. Do not substitute different pipe unless approved in writing before Substitutions. To request Substitution, refer to Section 01 25 00 Substitution Procedures.

2.2 PIPE HANGERS AND SUPPORTS

A. Properly support, suspend, or anchor all piping and fittings to prevent sagging, overstressing, or longitudinal movement, and to prevent thrust or loads on or against other equipment.

B. Support horizontal piping on adjustable split steel ring or clevis hangers. The following schedule shows minimum spacing:

Steel and Copper

1-1/4" and smaller	6'-0" on center
1-1/2" to 3"	8'-0" on center
4" and larger	12'-0" on center

PVC, CPVC, and ABS

1" and smaller	4'-0" on center
1-1/4" to 2"	5'-0" on center
2-1/2" to 4"	6'-0" on center
5" and larger	8'-0" on center

C. Support insulated piping with pipe saddles and hangers that fit on outside of insulation. Do not compress or damage pipe insulation with hangers or supports.

D. Provide all rigid hangers with a means of vertical adjustment after erection.

E. Use copper or copper plated hangers for supporting uninsulated copper pipe.

F. Use one of the following means of supporting horizontal piping from a wall.

1. Steel J-Hook for pipe located close to wall, up to three (3) inches pipe.

2. For hanger suspension with 750 lbs. maximum loading, use light welded steel bracket with hole for one rod, 3/4 inch diameter.

3. For pipe-roll stand support use welded—steel bracket.

G. For vertical piping supports for all pipe except copper:

1. Support vertical piping with wrought steel riser clamps. Make adequate provision for expansion, contraction, and lateral stability.

2. Use steel extension pipe clamps for vertical pipe supports. Refer to manufacturer's rated maximum loading for each size pipe. Bolt clamp securely to pipe rest, clamp end extension on building structure.

3. Where pipe sleeves extend above floor, place pipe clamps at ceiling below, support clamp end extension from inserts.

H. For uninsulated vertical copper tubing lines, furnish copper tube straps.

I. Use beam clamps that are of malleable iron for 3/8 inch hanger rods; forged steel beam clamp for hanger rod up to I-1/2 inches.

2.3 INSERTS

A. Furnish and set inserts in concrete forms; provide reinforcing rods for pipe sizes over three (3) inches or equivalent.

B. Furnish concrete inserts as follows: Black, malleable iron, universal type for threaded connections with lateral adjustment.

2.4 SHIELDS

A. Provide shields to protect insulation in all areas.

B. Provide approved galvanized form shields to protect insulation at areas of contact with hangers and supports.

C. Furnish low compressive insulation protector shields. Size per shield manufacturer's recommendations.

2.5 SLEEVES

A. Where pipes pass through floors, footings, foundations, walls, or ceilings, furnish and install pipe sleeves. Sleeves for concealed piping shall be of galvanized iron, and for exposed piping on I.P.S. black steel pipe installed so as to be completely covered by escutcheons. Extend sleeves through floors 1/2 inch above finish floor.

2.6 ESCUTCHEONS

A. Fit pipe passing through walls, floors, or ceilings with escutcheons with set screws.

B. Use prime painted escutcheons where surface is to receive a paint finish; otherwise, use escutcheons that are nickel or chromium plated.

C. Where piping is insulated, use escutcheon outside the insulation.

2.7 JOINTS

A. For screwed pipe make ends with sharp, clean tapered threads using pipe compound on male thread only. Do not use mill cut threads. Ream cut pipe to full inside diameter.

B. Welding may be done by either arc or acetylene process, ASME B3l.1.

C. For solder joints use fittings specifically made for soldering. Clean all burrs and roughen pipe to clean. Solder complete around joint.

D. For grooved pipe jointing systems use mechanical pipe couplings and fittings.

E. For no-hub cast iron pipe use double screw joint neoprene coupler.

2.8 UNIONS

A. Furnish and install unions necessary for installation and necessary to permit removal of equipment.

B. For unions in steel pipe 1-1/2 inches and smaller use malleable iron ground joint unions with brass to iron seat, galvanized or black as required.

C. For larger unions in steel pipe use standard weight, cast iron flange unions with 1/16 inch thick gaskets, galvanized or black as required.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation of piping, verify that it will not interfere with clearances required for the erection and finish of structural members, architectural members, electrical, sprinkler, or mechanical items.

B. Hang or support piping materials from roof support system whenever possible.

C. Do not cut any structural members for installation of piping.

3.2 INSERTS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over four (4) inches in diameter.

C. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

D. Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.3 SLEEVES

A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.

B. Extend sleeves through potentially wet floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where piping passes through floor, ceiling, or wall, close-off space between pipe and construction with noncombustible insulation. Provide tight-fitting metal caps on both sides and caulk.

3.4 PIPE HANGERS AND SUPPORTS

A. Support all piping and make adequate provisions for expansion, contraction, slope, and anchorage.

B. The use of pipe hooks, chains, or perforated metal for pipe support will not be permitted.

C. Suspend all piping in the building as indicated.

D. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.

E. Place a hanger within 1 foot of each horizontal elbow.

F. Use hangers that are vertically adjustable 1-1/2 inches minimum after piping is erected.

G. Support horizontal soil pipe near each hub, with five (5) feet maximum spacing between hangers.

H. Support vertical piping at every other floor. Support vertical soil pipe at each floor and at hub.

I. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

J. Where practical, support riser piping independently of connected horizontal piping.

3.5 PIPING INSTALLATION

A. Cut piping accurately for fabrication to measurements established at the construction site and work into place without springing or forcing.

B. Remove burrs and cutting slag from pipe by rearing or other approved cleaning methods.

C. Make changes in direction with proper fittings.

D. Arrange piping so as not to interfere with the removal of other equipment, ducts, or devices. Do not block doors, windows, or access openings. Provide unions in the piping at connections to all equipment. Unions must be accessible.

E. Make connections of dissimilar metals (such as copper and steel) with insulating couplings suitable for at least 175 psig working pressure at 250 deg F.

F. Cap or plug open ends of pipes and equipment with PVC caps or expanding neoprene plugs to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton, waste, or similar materials are not acceptable.

G. Install all piping systems so they can easily be drained. Provide hose bibs at low point of water lines.

H. Slope all soil and waste lines within the building at 1/4 inch per foot fall in the direction of flow unless indicated otherwise.

3.6 PRIMING AND COATING

A. Prime coat exposed steel hangers and supports and hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces.

3.7 DISINFECTION AND TESTING

A. Disinfect culinary water piping, Section 33 13 00 Disinfection.

B. Performance testing culinary water piping, Section 33 08 00 Commissioning of Water Utilities.

C. Repair defects that develop under tests promptly and repeat tests. No caulking of screwed joints, cracks, or holes will be permitted. Replace pipe or fitting or both with new material when repairing leaks in screwed joints.

D. Repair leaks in copper tubing by melting out joint, thoroughly cleaning both tubing and fitting, and resoldering.

3.8 FIELD QUALITY CONTROL

A. Inspect installed piping system for proper installation.

B. Perform hydrostatic pressure testing to ensure system is leak-free.

C. Test operation of all valves and accessories.

END OF SECTION

Division 23 – Heating, Ventilating, and Air Conditioning

SECTION 23 05 00

MECHANICAL GENERAL REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements for mechanical systems.
2. General requirements for submittals, labeling, and servicing mechanical systems.
3. Locating equipment and test run mechanical systems.

1.2 RELATED SECTIONS

01 25 00 – substitution procedures

01 31 00 – Project Management and Coordination

1.3 REFERENCES

A. Not Applicable.

1.4 SUBMITTALS

A. General: Submittals must indicate proper arrangements to suit installation and maintenance requirements such as but not limited to motor location, access door openings, filter removal, piping connections. Clearly mark equipment submittal sheets indicating equipment symbol and exact selection of proposed equipment.

B. Shop Drawings: Submit complete, bound, indexed, loose leaf binder large enough for all items, including:

1. Equipment schedule items.
2. Vibration elimination devices.
3. Piping and valves.
4. Insulation.
5. Registers and grilles.
6. Automatic temperature controls.
7. Certificates of guarantee.
8. Pipe Tests: If requested, submit a report of tests performed by pipe manufacturer and the date each test was completed.

1.5 QUALITY ASSURANCE

A. Work shall be carried out by personnel who are skilled in their respective trades and properly supervised by experienced personnel.

B. CONTRACTOR shall obtain all necessary permits and licenses required for work to proceed and shall comply with all applicable regulations, standards, and codes.

C. All installations should comply with manufacturer's recommendations and guidelines.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 LABELING

A. Identify all critical items of equipment with permanently etched, laminated plastic labels indicating function or relationship of each piece of equipment to system involved. Secure all labels in place in a clearly visible location with appropriate self-tapping screws.

B. Mark pipe continuously to identify such information as nominal size, pressure rating, industry standards designation number, flow direction, etc.

1.8 SERVICE

A. Provide emergency service for mechanical systems.

B. In the event of a system Failure, OWNER shall be able to telephone a single request for complete service call by using a number furnished under the contract. The service organization shall dispatch in the time specified by the ENGINEER a person to the site who shall be able to analyze the systems and locate the malfunction. If work should be required out of the normal trade definition, it shall be the responsibility of this service organization to contact the CONTRACTOR or any other specialty involved, and take the responsibility of completing the repairs and putting the system into operation.

C. Service shall be provided by a service business, established and experienced in this work. Complete information in regard to this service organization, showing the personnel, equipment, location, experience, etc., shall be submitted for review along with other items of the system.

D. This service shall be provided starting at the date of Substantial Completion, and for the duration of the CONTRACTOR's guarantee period.

1.9 SUBSTITUTIONS

A. Section 01 25 00 Substitution Procedures.

B. Resolve any conflict arising from use of substituted equipment.

C. Pay all costs required to make equipment comply with intent of Contract Documents. All approvals shall be obtained in writing.

1.10 COORDINATION

A. Section 01 31 00, Project Management and Coordination.

B. Plan all work to proceed with a minimum of interference with other trades.

C. Inform affected trades of all openings for mechanical work.

D. Furnish all special frames and sleeves as indicated in other Sections.

1.11 PRODUCT HANDLING

A. Section 01 65 00, Product Delivery and Handling.

B. Deliver all materials to the job bearing manufacturer's name and trade name and UL label in every case where a standard has been established for that particular material.

C. Store product in original containers, protect from elements, and make readily accessible for inspection until ready for installation.

1.12 PROJECT CONDITIONS

A. Notify ENGINEER if a discrepancy occurs between the equipment supplied and the intent or function of the equipment, catalog numbers, discontinued products, Drawings, Specifications, etc.

B. Failure to report any conflict does not relieve CONTRACTOR from meeting the intent of the Contract Documents nor shall it change the contract cost.

C. Perform all required digging, cutting, incidental work, and make required repairs.

D. Do not cut into any structural element without ENGINEER's knowledge.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Where two (2) or more units of the same class of new equipment are required, provide units of single manufacturer.

B. Use standard products of the manufacturer unless indicated otherwise.

2.2 MATERIALS

A. All materials should be new, free from defects, and as per manufacture's specifications.

B. All ferrous materials exposed to weather or damp locations shall be rust-proofed.

C. All flammable materials shall conform to local and national fire safety standards.

PART 3 - EXECUTION

3.1 ROUGH IN REQUIREMENTS

A. Refer to architectural, structural, mechanical, civil and electrical Drawings.

B. Verify that equipment dimensions meet space requirements with sufficient clearances as may be required by equipment used and as indicated.

C. Check building and equipment dimensions for exact placement of sleeves, conduit and equipment.

D. Determine requirements and dimensions relating to manufacturer's Shop Drawings.

E. Make changes required due to lack of coordination at no additional cost to OWNER.

3.2 ACCESSIBILITY FOR MAINTENANCE

A. Coordinate location of equipment such as valves, dampers, fixtures, motors, fans, controls, etc. to allow accessibility for maintenance.

B. Ensure access for service or maintenance for proper operation and function.

C. To facilitate function, coordinate mechanical work of all other trades to avoid concealing equipment.

D. Refer any critical location or assembly conflicts to ENGINEER.

3.3 TEST RUN

A. Perform preliminary operation of all mechanical systems in cooperation with all trades involved.

B. Arrange time of test run.

C. Make operating test by a team consisting of manufacturer's representative, CONTRACTOR's representative, and ENGINEER.

D. Complete test run in one (1) working day including possible different date identification and recheck of significant items under different working conditions.

3.4 INSTALLATION

A. Installation shall be carried out as per manufacturer's guidelines and in accordance with the project plan.

B. Install mechanical systems so that they can operate without causing excessive noise, vibration, or other disturbances.

C. Ensure that all installations are level, aligned, and securely fastened.

3.5 FIELD QUALITY CONTROL

A. Perform inspections and tests during installation and upon completion to ensure conformance to the contract documents.

B. Defective equipment or systems shall be replaced or repaired at the CONTRACTOR's expense.

3.6 TRAINING

A. Provide training to OWNER's personnel on operation and maintenance of the systems.

B. Training shall be performed by qualified personnel and should include documentation for future reference.

PART 4 - MAINTENANCE

4.1 MAINTENANCE SERVICE

A. Provide all necessary maintenance documentation, including operation and maintenance manuals, troubleshooting guides, and spare parts lists.

B. Assist OWNER in establishing a preventative maintenance schedule.

C. Ensure availability of spare parts and technical support for a period of five years from date of substantial completion.

END OF SECTION

SECTION 23 83 16

SNOWMELT SYSTEM AND PIPING

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes radiant heating piping, including pipes, fittings, and piping specialties.

1.2 REFERENCES

A. Related Documents

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 23 Specification Sections, apply to this Section.

1.3 SUBMITTALS

A. Product Data: For each type of radiant heating pipe, fitting, manifold, specialty, and control.

1. For radiant heating piping and manifolds, include pressure and temperature rating, oxygen-barrier performance, fire-performance characteristics, and water flow and pressure drop characteristics.

2. Distribution manifolds

3. Manifold Cabinets

4. Slab Snow / Ice Sensor

B. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.

1. Snowmelt system hydronic and heat transfer performance data generated by snowmelt piping manufacturer’s computer layout software. Data shall include:

a. Heat output in BTUH/ft.

b. Fluid pressure drop through the snowmelt radiant piping, from the supply manifold to the return manifold.

c. Snowmelt fluid supply temperature, return temperature, and flow rate.

d. Snowmelt pipe circuiting, pipe size, and pipe routing in each snowmelt slab.

2. Locations of manifold cabinets surface mounted on walls, and sleeves where snowmelt pipe rises out of slab.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.

D. Operation and Maintenance Data: For radiant heating piping valves and equipment to include in operation and maintenance manuals.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. PEX: Crosslinked polyethylene.

C. CWP: Cold working pressure.

PART 2 – PRODUCTS

2.1 PEX PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other approved equal:

1. HeatLink USA Inc.
2. Stadler-Viega.
3. Uponor Wirsbo Co.
4. Vanguard Piping Systems, Inc.
5. Warmboard, Inc.
6. Watts Radiant, Inc.; a division of Watts Water Technologies, Inc.
7. Roth.

B. Pipe Material: PEX plastic according to ASTM F 876.

C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

D. Fittings: ASTM F 1807, metal insert and copper crimp rings.

E. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

F. Flame-Spread and Smoke-Developed Indices: 25 and 50 or less, respectively, tested according to ASTM E 84.

2.2 EPDM PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Watts Radiant, Inc.; a division of Watts Water Technologies, Inc.

2. Prior approved equal.

B. Pipe Material: Crosslinked EPDM (ASTM D1418 Class M) inner and outer tubes.

C. Wall Thickness: Minimum 0.125 inch.

D. Oxygen Barrier: Ductile aluminum foil layer applied to the inner tube to limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

E. Reinforcing Braid: Braided-aluminum wire between the inner and outer tube.

F. Fittings: ASTM F 1807, copper with stainless-steel crimps or clamps.

G. Pressure/Temperature Rating: Minimum 100 psig and 210 deg F.

2.3 DISTRIBUTION MANIFOLDS

A. Manifold: Minimum NPS 1, copper or brass.

B. Main Shutoff Valves:

1. Factory installed on supply and return connections.

2. Three-piece body.

3. Body: Brass or bronze.

4. Ball: Chrome-plated bronze.

5. Seals: PTFE.

6. CWP Rating: 150 psig.

7. Maximum Operating Temperature: 225 deg F.

C. Manual Air Vents:

1. Body: Bronze.

2. Internal Parts: Nonferrous.

3. Operator: Key furnished with valve, or screwdriver bit.

4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

D. Balancing Valves:

1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
6. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
7. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

E. Zone Control Valves:

1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Actuator: Replaceable electric motor.
6. CWP Rating: Minimum 125 psig.
7. Maximum Operating Temperature: 250 deg F.

F. Thermometers:

1. Mount on supply and return connections.
2. Case: Dry type, metal or plastic, 2-inch diameter.
3. Element: Bourdon tube or other type of pressure element.

4. Movement: Mechanical, connecting element and pointer.

5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

6. Pointer: Black metal.

7. Window: Plastic.

8. Connector: Rigid, back type.

9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.

10. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

G. Mounting Brackets: Copper, or plastic or copper-clad steel, where in contact with manifold.

2.4 Manifold Cabinets

A. Surface mounted with galvanized or stainless-steel back plate, stainless steel sides/top/bottom, stainless steel hinged door with handle that rotates 90 degrees to secure door and removable lock cylinder in handle. All cabinets to be provided with identical key sets so one key will lock/unlock all cabinets. Provide minimum 4 keys per manifold cabinet. Minimum cabinet dimensions 40” x 28” x 4”.

B. Back plate to include horizontal rails, adjustable vertical rails, and mounting brackets for the radiant manifolds.

2.5 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

2. Minimum Width: 1/8 inch.

3. Tensile Strength: 20 lb, minimum.

4. Temperature Range: Minus 40 to plus 185 deg F.

B. Floor-Mounting Staples:

1. Steel, with corrosion-resistant coating and smooth finish without sharp edges.

2. Minimum Thickness: 3/32 inch.

3. Width: Minimum, wider than tubing.

C. Floor-Mounting Clamps:

1. Two bolt, steel, with corrosion-resistant coating and smooth finish without sharp edges.

2. Minimum Thickness: 3/32 inch.

3. Width: Minimum, wider than tubing.

D. Floor Mounting Tracks:

1. Aluminum or plastic channel track with smooth finish, no sharp edges.

2. Minimum Thickness: 1/16 inch.

3. Slot Width: Snap fit to hold tubing.

4. Slot Spacing: 2-inch intervals.

E. Modular Interlocking Blocks:

1. Polypropylene snap-together blocks with grooves to support piping.

2. Galvanized sheet metal or aluminum emission plates.

3. Natural mineral board cover panel.

F. Heat-Emission Plates:

1. Formed aluminum suitable for radiant heating piping.

2. Minimum Thickness: 1/16 inch.

3. Slot Width: Snap fit to maintain pressure fit on tubing.

G. Galvanized Wire Mesh:

1. Steel mesh with galvanized finish, on a minimum 6” x 6” grid, used to hold snowmelt pipe in place as slab is poured. Include galvanized steel chairs to hold the wire mesh and snowmelt pipe at the proper elevation during slab pour.

2.6 CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alerton VLCA-1688 controller.

B. Precipitation and Temperature Sensor:

1. Microprocessor-based control with manual on, automatic, and standby/reset switch.

2. Precipitation and temperature sensors shall sense the surface conditions of pavement and shall be programmed to operate pump and zone control valves as follows:

a. Temperature Span: 34 to 44 deg F.

b. Adjustable Delay Off Span: 30 to 90 minutes.

c. Start Pump or Open Zone Control Valves: Following two-minute delay if ambient temperature is below set point and precipitation is detected.

d. Stop Pump or Close Zone Control Valves: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.

4. Minimum 30-A contactor to start pump and open valves.

5. Precipitation sensor shall be mounted in empty conduit below the slab.

6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control system workstation.

7. Relays for lighting control system provided by division 26.

8. See drawings for other controls boards and required points.

2.7 SLAB SNOW/ICE SENSOR

A. Approved Manufacturer: Tekmar.

B. Sensor constructed of silicon brass sensor intended for installation in outdoor slab, with 5 conductor stranded wire with polyethylene jacket.

C. Provide with silicon brass socket that is installed directly into the outdoor slab. Sensor to be secured to socket with stainless steel screws. Socket to include connection point for conduit cast in slab, through which control wiring off sensor shall be routed.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive radiant heating piping for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure that surfaces and pipes in contact with radiant heating piping are free of burrs and sharp protrusions.

2. Ensure that surfaces and substrates are level and plumb.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Install the following types of radiant heating piping for the applications described:

1. Piping in Exterior Pavement and Stairs: EPDM.

2. Piping in Interior Reinforced-Concrete Floors: PEX.

3. Piping in Level Fill Concrete Floors (Not Reinforced): PEX.

3.3 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop or Coordination Drawings.

B. Install radiant heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.

C. Connect radiant piping to manifold in a reverse-return arrangement.

D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.

E. Install manifolds in accessible locations or install access panels to provide maintenance access as required in Division 8 Section "Access Doors and Frames."

F. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

G. Piping in Exterior Pavement and Stairs:

1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.

2. Space cable ties a maximum of 18 inches on-center (o.c.), and at center of turns or bends.

3. Maintain 3-inch minimum cover.

4. Install a sleeve of 3/8-inch- thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.

5. Prior to pouring slab, a detailed as-built drawing shall be prepared with the location of all piping dimensioned and accurately located. The supplier shall visit the site and confirm in writing that the installation is in conformance with the snowmelt pipe manufacturer’s instructions and circuiting drawings, and that all manufacturer’s recommendations have been followed.

6. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.

H. Piping in Interior Reinforced-Concrete Floors:

1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.

2. Space cable ties a maximum of 18 inches o.c., and at center of turns and bends.

3. Maintain 2-inch minimum cover.

4. Install a sleeve of 3/8-inch-thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.

5. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.

I. Piping in Level Fill Concrete Floors (Not Reinforced):

1. Secure piping in concrete floors by attaching pipes to subfloor using tracks, clamps, or staples.

2. Space tracks, clamps, or staples a maximum of 18 inches o.c., and at center of turns or bends.

3. Maintain 3/4-inch minimum cover.

4. Install a sleeve of 3/8-inch-thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.

5. Maintain minimum 40-psig pressure in piping during the concrete pour and continue for 24 hours during curing.

J. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by ENGINEER.

K. After system balancing has been completed, mark balancing valves to permanently indicate final position.

L. Perform the following adjustments before operating the system:

1. Open valves to fully open position.

2. Check operation of automatic valves.

3. Set temperature controls so all zones call for full flow.

4. Purge air from piping.

M. After the concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant heating system as follows:

1. Start system heating at a maximum of 10 deg F above the ambient radiant panel temperature, and increase 10 deg F each following day until design temperature is achieved.

2. For freeze protection, operate at a maximum of 60 deg F supply-water temperature.

3.4 FIELD QUALITY CONTROL

A. Prepare radiant heating piping for testing as follows:

1. Open all isolation valves and close bypass valves.

2. Open and verify operation of zone control valves.

3. Flush with clean water, and clean strainers.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning radiant heating piping components that do not pass tests, and retest as specified above. Snowmelt piping will be considered defective if it does not pass tests and inspections.

D. Prepare a written report of testing.

E. Protect snowmelt piping system from damage during construction.

END OF SECTION

Division 26 – Electrical

SECTION 26 05 00

ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements for electrical systems.

2. Requirements for electrical system layouts, interpretations of drawings and specifications, quality assurance, coordination, submittals, operation and maintenance manuals, record drawings, product handling, project conditions, and warranty.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.

a. Note to Designer: This is required for projects with Federal Funds.

1.2 RELATED SECTIONS

01 25 00 – Substitution Procedures

01 31 00 – Project Management and Coordination

07 84 13 – Penetration Firestopping

1.3 REFERENCES

A. NFPA Standards 70: National Electrical Code

1.4 SUBMITTALS

A. Electrical installation certificate from electrical inspection authority having jurisdiction.

B. Wiring Layout: Before installation of the electrical work, submit a complete wiring layout, showing arrangement of all circuits, conduits, and control equipment, size of conduit, conductors, wiring diagrams and connections of all equipment necessary for full understanding and record of the installation.

C. The CONTRACTOR shall submit complete shop drawings and other required submittals. Incomplete submittals will be returned to the CONTRACTOR unreviewed. No time extensions or cost increases will be allowed for delays caused by the return of incomplete submittals.

D. Shop Drawings: After the contract is awarded, but prior to manufacture or installation of any equipment, submit electronic copy (PDF format) of shop drawings. Partially complete sets of shop drawings are not acceptable. Submit all shop drawings in one complete submittal package. Prior to submitting shop drawings, review and certify that they are in compliance with the contract documents; Sign all approved shop drawings. Allow a minimum of two weeks for the ENGINEER to review the shop drawings. Refer to architectural general provision section for additional requirements.

E. Provide equipment catalog “cut sheets”, brochures and/or drawings which clearly describe the proposed equipment. Include plans, elevations, sections, isometrics, and detailed engineering and dimensional information as applicable including equipment room layouts. Electrical room layouts are required to show all electrical equipment locations for all projects that include electrical rooms. Do not submit catalog “cut sheets” which describe several different items in addition to those items to be used, unless all relevant information is clearly identified. Bind each information set in three ring binder or binders of sufficient size or sizes to enclose all information. Organize all information by section. Provide separate tabbed covers for each section of Divisions 26, 27, and 28, indicating section number for each section requiring submittals.

F. Include on front cover of binder or binders the name and location of the project, architect, electrical engineer, general contractor, electrical contractor, subcontractors, supplier/vendor, order number, volume, date, and any other applicable information. Certify that shop drawings are submitted in accordance with the contract documents with a written statement indicating compliance. Submittals will be reviewed and comments produced two times maximum. Additional reviews will be billed at current rates.

1.5 QUALITY ASSURANCE

A. Workmanship to be neat with good appearance, NFPA 70.

B. Perform work in accordance with all governing codes, rules, and regulations including the following minimum codes (latest editions or as otherwise accepted by the Authorities Having Jurisdiction):

1. National Electric Code (NEC)
2. International Building Code (IBC)
3. International Fire Code (IFC)
4. International Mechanical Code (IMC)
5. International Plumbing Code (IPC)
6. American Disability Act (ADA)
7. National Electrical Safety Code (NESC)
8. Local Codes and Ordinances

C. Comply with all standards where applicable for equipment and materials including the following minimum standards:

1. Underwriter's Laboratories (UL)
2. American Society for Testing Materials (ASTM)
3. Certified Ballast Manufacturers (CBM)
4. Insulated Cable Engineers Association (ICEA)
5. National Electrical Manufacturer's Institute (NEMA)
6. American National Standards Institute (ANSI)
7. Electrical Testing Laboratories (ETL)
8. National Fire Protection Association (NFPA)
9. Institute of Electrical and Electronics Engineers (IEEE)
10. American Institute of Electrical Engineer's Electrical Power
11. Systems Commercial Construction
12. Illuminating Engineers Society (IES)

D. Provide new electrical equipment conforming to all requirements as set forth in the above standards. Provide UL labeled equipment where such label is applicable.

E. Comply with all state and local codes and ordinances. When conflicts occur among codes, standards, drawings, and/or specifications, the most stringent requirements shall govern.

F. Obtain all permits, inspections, etc. required by authority having jurisdiction. Include all fees in bid. Provide a certificate of approval to the OWNER's representative from the inspection authority at completion of the work.

G. The CONTRACTOR shall have a current state contracting license applicable to type of work to be performed under this contract.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 ELECTRICAL SYSTEM LAYOUTS

A. Drawings are diagrammatic, intended to indicate general scope and locations of work to be installed.

B. Furnish, as if called for in detail by the Contract Documents, all items of labor and material or equipment incidental to or necessary for the complete installation and proper operation of electrical work.

C. Adhere to applicable building codes, safety regulations, and industry standards (e.g., NEC, IEC) for electrical system layouts and installations.

1.8 INTERPRETATIONS OF DRAWINGS AND SPECIFICATIONS

A. Prior to bidding the job, submit requests for clarification in writing to the ENGINEER prior to issuance of the final addendum.

B. After signing the contract, provide all materials, labor, and equipment to meet the intent, purpose, and function of the contract documents.

C. The following terms used in Division 26, 27, and 28 documents are defined as follows:

1. “Provide” - Means furnish and connect, unless otherwise indicated.

2. “Furnish- Mean purchase new and deliver in operating order to the project site.

3. "Install" - Means to physically install the items in-place.

4. "Connect" - Means make final electrical connections for a complete operating piece of equipment. This includes providing conduit, wire, terminations, etc. as applicable.

5. "Or Equivalent" - Means to provide equivalent equipment. Such equipment must be approved by the ENGINEER prior to bidding.

1.9 EXAMINATION OF SITE

A. Visit the site and verify existing field conditions prior to submitting bid.

1.10 SUBSTITUTIONS

A. See Section 01 25 00 Substitution Procedures.

B. Resolve any conflict arising from use of substituted equipment.

C. Provide only specified products or products approved by addendum. Substitutions will be considered if two copies of the proposal are received at the Engineer's office eight (8) working days prior to the bid day. Include in the proposal the specified and proposed catalog numbers of the equipment under consideration and a catalog cut sheet(s) with pictorial and descriptive information. Certify that the equipment proposed is equal to that specified, that it has the same electrical and physical characteristics, compatible dimensions, is compatible with existing systems or components, and meets the functional intent of the contract documents. All approvals shall be obtained in writing.

D. It is the responsibility of the CONTRACTOR to make all substituted equipment comply with the intent of the contract documents and bear all cost associated with conflicts arising from the use of substituted equipment.

E. Provide samples if required by the Engineer for approval.

1.11 COORDINATION

A. See Section 01 31 00 – Project Management and Coordination.

B. Plan all work to proceed with a minimum of interference with other trades.

C. Inform affected trades of all openings for electrical work.

D. Furnish all special frames and sleeves as indicated in other Sections.

E. Hold regular coordination meetings among trades to ensure smooth project execution, identify potential conflicts early, and foster communication among stakeholders. Specify the frequency (e.g., weekly, bi-weekly) and attendees (e.g., representatives from each trade) of these meetings.

1.12 OPERATION AND MAINTENANCE MANUALS

A. Submit electronic copy (PDF format) of operating instruction and maintenance manuals for all equipment and materials provided under Divisions 26, 27, and 28.

B. Provide manufacturer's recommended operating and maintenance instructions, cleaning and servicing requirements, serial and model number of each piece of equipment, complete list of replacement parts, performance curves and data, wiring diagrams, warranties, and vendor's name, address, and phone numbers. Do not submit information which describes several different items in addition to those items to be used, unless all relevant information is clearly identified. Assemble all data in completely indexed volume or volumes. Engrave the job title, and name, address, and phone numbers of the CONTRACTOR on the front cover and on the spine. Incomplete O&M manuals will be returned to the CONTRACTOR for corrections / additions.

1.13 RECORD DRAWINGS

A. Maintain on a daily basis a complete set of "Red-Lined Drawings", reflecting an accurate record of all work including addendums, revisions, and changes. Indicate precise dimensioned locations of all concealed work and equipment, including concealed or embedded conduit, junction boxes, etc. Record all "Red-Lined Drawing" information on a set of full sized prints of the contract drawings.

B. Certify the "Red Lined Drawings" for correctness. Indicate on each drawing the name of the general and electrical contractors with signatures of each representative responsible for the work.

C. The electrical engineering design firm will create record (as-built) drawings from the certified red-lined drawings; however, the general and electrical contractors retain the responsibility for the accuracy of the record drawings.

1.14 PRODUCT HANDLING

A. Deliver all materials to the job bearing manufacturer's name and trade name and UL label in every case where a standard has been established for that particular material.

B. Store product in original containers, protect from elements, and make readily accessible for inspection until ready for installation.

1.15 PROJECT CONDITIONS

A. Notify the ENGINEER if a discrepancy occurs between the equipment supplied and the intent or function of the equipment, catalog numbers, discontinued products, drawings, specifications, etc.

B. Failure to report any conflict does not relieve CONTRACTOR from meeting the intent of the contract documents nor shall it change the contract cost.

C. Perform all required digging, cutting, incidental work, and make required repairs.

D. Do not cut into any structural element without ENGINEER’s knowledge.

E. Maintain site safety and cleanliness by adhering to safety regulations, performing regular site clean-up, storing materials properly, and using personal protective equipment (PPE) as required.

1.16 WARRANTY

A. Ensure that the electrical system installed under this contract is in proper working order and in compliance with drawings, specifications, and/or authorized changes and is free from electrical defects. Without additional charge, replace or repair, to satisfaction of the OWNER's representative, except from ordinary wear and tear, any part of the installation which may fail or be determined unacceptable within a period of one (1) year after final acceptance or as otherwise indicated in individual sections, but in no case less than one year. Warranty incandescent and fluorescent lamps only for a period of two months from the date of substantial completion.

B. Provide complete warranty information for each item including beginning of warranty period, duration of warranty, names, addresses, and telephone numbers and procedures for filling a claim and obtaining warranty services. Written warranties and guarantees are to be submitted separately as:

   1. Originals bound in a binder clearly identified with the title, “WARRANTIES AND GUARANTEES,” the project name, the project number, and the CONTRACTOR’s business name.

   2. Electronic documents in *.pdf format.

PART 2 – PRODUCTS

2.1 GENERAL

A. All materials shall be new and shall bear the manufacturer's name, trade name, and the approved testing laboratory such as the UL label in every case where a standard has been established for that particular material. Used materials are acceptable only if specifically indicated on drawings.

2.2 SUBSTITUTION OF MATERIALS

A. Provide only specified products or products approved by addendum. Substitutions will be considered if two copies of the proposal are received at the ENGINEER's office eight (8) working days prior to the bid day. Include in the proposal the specified and proposed catalog numbers of the equipment under consideration and a catalog cut sheet(s) with pictorial and descriptive information. Certify that the equipment proposed is equal to that specified, that it has the same electrical and physical characteristics, compatible dimensions, and meets the functional intent of the contract documents.

B. It is the responsibility of the CONTRACTOR to make all substituted equipment comply with the intent of the contract documents and bear all costs associated with conflicts arising from use of substituted equipment.

C. Provide samples if so, required by the ENGINEER before or after bid day.

PART 3 – EXECUTION

3.1 GENERAL

A. Workmanship: Provide only first-class workmanship from competent workers. Defective materials or workmanship will not be allowed on the project. Provide competent supervision for the work to be accomplished. Keep same foreman on the job, unless a change is authorized by the ENGINEER.

B. Coordination: Prior to construction, layout electrical work and coordinate work with other trades. Sequence, coordinate, and integrate installation of materials and equipment for efficient flow of the work. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components. Coordinate with all utilities including power, communication, and data installations.

C. Provide cutting, drilling, channeling, etc. only as necessary for proper completion of the work. Do not cut structural members unless authorization is issued in writing by the ENGINEER.

D. Repairs: Repair damage to building, grounds, or utilities as a result of work under this contract at no additional cost to the OWNER.

E. Dimensioning: Electrical drawings indicate locations for electrical equipment only in their approximate location, unless specifically dimensioned. Do not scale electrical drawings for dimensional information. Refer to architectural drawings and shop drawings where applicable for locations of all electrical equipment. Field verify all dimension on the job site.

F. Provide block-outs, sleeves, demolition work, etc., required for installation of work specified in this division.

G. Standards: Provide electrical installation in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

H. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

I. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

J. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

K. Right of Way: Give to piping systems installed at a required slope.

L. All workmen doing work of any nature on State of Utah projects must at all times carry their electrician's license with them and show it upon request. The acceptable ratio of apprentice to journeyman electricians on the job is 1:1.

3.2 REQUESTS FOR INFORMATION

A. When it is clearly apparent that information is not adequately described in the construction documents or when a coordination problem exists, submit a request for information (RFI) through proper contractual channels. The electrical engineering design firm will provide a response through its contractual channel. Although verbal direction may be given to expedite changes, responses are not considered part of the contract documents until a change order has been issued and signed by the OWNER or his designated representative. The CONTRACTOR shall bear all costs associated with proceeding on any change order that has not been approved by the OWNER or his designated representative.

B. Any damages caused by construction delays due to frivolous RFI’s, will be born solely by the CONTRACTOR.

3.3 SAFETY PRECAUTIONS

A. Provide all necessary guards or construction barriers and take all necessary precautions to insure the safety of life and property.

3.4 CLEAN

A. Clean up all equipment, conduit, fittings, wire, packing cartons, plastic, and other debris that is a direct result of the installation of the work of this division, both during the execution, and at the conclusion, of the project. Keep the site clean and safe during the progress of the work. Clean fixtures, interior and exterior of all equipment, and raceways prior to final acceptance. Vacuum interior of all electrical panels and equipment. Correct any damaged equipment. Touch-up or repaint if necessary.

3.5 TEMPORARY POWER

A. Make arrangements with the proper institution authority for all temporary electricity.

B. Provide temporary power, complete with metering and wiring for lighting and power outlets for construction tools and equipment. Report the initial meter reading to the OWNER/institution, or otherwise as may be directed.

C. Service shall be provided with a main disconnect and all 20 ampere receptacles protected by 20 amp GFI, single-pole breakers. No attempt is made herein to specify construction power requirements for equipment in detail. Provide all electrical equipment and wiring as required.

D. As soon as permanent power and metering is available, the temporary power supply shall be disconnected and removed from the project site.

E. All temporary wiring shall meet the requirements of NEC Article 590 and the State Industrial Commission.

3.6 POWER OUTAGES

A. All power outages required for execution of this work shall occur during non-standard working hours and at the convenience of the OWNER. Any electrical service interruption will be coordinated at least 7 days in advance of the power shut-off. Include all costs for overtime work in bid. Coordinate all outages and proceed only after receiving authorization from the OWNER's representative. Keep all outages to an absolute minimum.

3.7 STORAGE AND PROTECTION OF MATERIALS

A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. Lost or damaged materials will be replaced at no additional cost to OWNER. Do not store materials and apparatus in any public thoroughfare or in any area on the site where such storage would constitute a hazard to persons in the vicinity. Protect completed work, work underway, and apparatus against loss or damage.

3.8 EXCAVATING FOR ELECTRICAL WORK

A. Verification: Prior to excavating, locate and protect existing utilities and other underground work in a manner which will ensure that no damage or service interruption will result from excavating and backfilling. Observe all State and Local codes prior to excavating. Do not disturb walls, footings, and other structural members in any way.

B. Protection: Provide barricades, warning signs, and illumination to protect persons from injury at excavations. Provide temporary coverings and heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install electrical work on frozen excavation bases or subbases.

C. Coordination: Do not excavate for electrical work until the work is ready to proceed without delay.

D. Excavated Materials: Temporarily store excavated materials near excavation in manner which will not interfere with or damage excavation or other work. Dispose of and remove excavated materials which are either in excess of quantity needed for backfilling or do not comply with the requirements for backfill material.

E. Burial Depths: Burial depths must comply with NEC Section 300-5 (or State of Utah requirements, whichever is more stringent), unless noted otherwise on drawings.

F. Excavation Permits: Obtain all shut-down and excavation permits as may be required for proper completion of the work.

3.9 BACKFILL MATERIALS

A. For buried conduits or cables (other than below slab-on-grade, or concrete-encased), provide 2" thickness of well-graded sand on all sides of conduits or cables.

B. For trench backfill to within 6" of final grade, provide soil material suitable for compacting to required densities.

C. For top 6" of excavation, provide top soil.

D. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (percent of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.

E. Lawn/Landscaped Areas: 85 percent for cohesive soils, 95 percent for cohesionless soils.

F. Paved Areas, other than roadways: 90 percent for cohesive soils, 95 percent for cohesionless soils.

G. Where subsidence is observable at electrical work excavations during project warranty period, remove surface, add backfill material, compact, and replace surface treatment. Restore surface to original condition.

3.10 ROOF PENETRATIONS

A. Where raceways and/or cables penetrate roofing, provide 26 gauge galvanized iron roof jack, sized to fit tightly to raceway and/or cable for weather-tight seal, and with flange extending a minimum of 9" under roofing on all sides. Seal opening between raceway and roof jack with approved sealant. Coordinate all work with division 7.

3.11 LABELING

A. Engraved black plastic laminated, with white-core labels, 1/16" thick, shall be permanently attached on both the interior and exterior the following electrical equipment:

1. Branch panels

2. Switchgear

3. Disconnect switches

4. Motor starter and controls junction boxes (power and auxiliary)
5. Push buttons
6. Thermal switches
7. Time switches
8. Motor control centers
9. Transformer
10. Similar equipment
11. Lighting contactors and associated switches
12. Junction boxes larger than 4x4x1/2

B. The labels shall have 1/4" high, engraved letters, such as EF-1, AC-1, Panel A, etc.

3.12 CONCRETE BASES

A. Housekeeping Pads: Unless otherwise noted, provide 4" high reinforced concrete bases for all floor-mounted or floor-standing electrical equipment. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 4000-psi, 28-day compressive-strength concrete and reinforcement. All this included but not necessarily limited to the following:

1. Transformers
2. Switchboards
3. Similar Equipment

B. Extend bases 6" beyond equipment or mounting rails on all sides or as shown on the drawings. Not withstanding this requirement, coordinate with equipment manufacturer, shop drawings, and height of base to ensure compliance with NEC 380-82.

C. Transformer Pads: Provide and locate properly sized concrete pads for power company furnished pad mounted transformers in accordance with power company clearance requirements.

3.13 TESTS

A. Notify ENGINEER prior to all testing specified herein at least three business days prior to testing. ENGINEER shall observe all tests to insure the proper operation of the electrical system.

3.14 PROJECT FINALIZATION AND START-UP

A. Upon completion of the work, have each factory representative and/or subcontractor assist in start-up and testing of their respective systems.

B. Have each representative give personal instructions on operating and maintenance of their equipment to the OWNER's maintenance and/or operation personnel.

C. Have representatives certify each system with a written statement indicating that they have performed start-up and final check out of their respective systems.

3.15 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in 07 92 00 “Joint Sealants.”

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in 07 84 13 “Penetration Firestopping.”

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.16 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.17 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 07 84 13 "Penetration Firestopping."

3.18 ACCESS DOORS

A. Provide access doors to maintain access to junction boxes, cable trays, open wiring systems and other equipment requiring access. Install access doors in locations approved by the ENGINEER. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

3.19 FINAL REVIEW

A. Have the project foreman accompany their reviewing parties and remove cover plates, panel covers, access panels, etc. as requested, to allow review of the entire electrical system.

END OF SECTION

SECTION 26 05 04

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.
    a. Note to Designer: This is required for projects with Federal Funds.

1.2 RELATED SECTIONS

01 60 01 **–** Buy America Requirements

07 84 13 **–** Penetration Firestopping

08 31 13 **–** Access Doors and Frames

1.3 REFERENCES

A. American Society of Testing and Materials (ASTM):

1. A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
2. E814 – Standard Test Method for Fire Tests of Penetration Firestop Systems

B. National Fire Protection Agency (NFPA) 70 – National Electrical Code (NEC).

C. Underwriters Laboratories (UL) 1479 – Fire Tests of Through-Penetration Firestops.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for sleeves and sleeve seals, including installation instructions.

B. Shop Drawings: Indicate sleeve types, sizes, and locations on construction drawings.

C. Certificates: Submit certifications confirming compliance with applicable standards.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has successfully completed installations similar in material, design, and extent to that indicated for the Project.

B. Regulatory Requirements: Comply with NEC, local codes, and authorities having jurisdiction for electrical installations.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. EPDM: Ethylene-propylene-dieneterpolymer rubber.

1.8 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping and conduit installed at required slope.

4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate electrical connections to equipment:

1. Refer to equipment manufacturer's shop drawings and written instructions. Provide all power and control wiring with associated raceways for complete operation.

2. Where equipment is furnished with a cord and plug, provide receptacle to match equipment plug.

3. Verify electrical requirements of equipment on nameplate and installation manual. Ensure that the electrical connections meet the requirements and notify ENGINEER of any discrepancies.

4. Meet with equipment manufacturers representatives to coordinate equipment installation and electrical connections.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

D. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section 08 31 13 Access Doors and Frames.

E. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 07 84 13 Penetration Firestopping.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

3. Pressure Plates: Carbon steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in 07 84 13 Penetration Firestopping.

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 07 84 13 "Penetration Firestopping."

3.6 ACCESS DOORS

A. Provide access doors to maintain access to junction boxes, cable trays, open wiring systems and other equipment requiring access. Install access doors in locations approved by the ENGINEER. Access doors and panels are specified in Division 08 Section Access Doors and Frames.

3.7 FIELD QUALITY CONTROL

A. Inspection: Inspect all installed sleeves and seals for proper installation, alignment, and tightness.

B. Testing: Perform water and fire-resistance tests on a representative sample of installed sleeve seals to ensure compliance with specifications.

3.8 PROTECTION

A. Protect installed sleeves and sleeve seals from damage during the remainder of construction.

B. B. Replace damaged sleeves or seals prior to project completion.

3.9 DOCUMENTATION

A. Submit test reports, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed products.

END OF SECTION

SECTION 26 05 13

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Installation of wires or cables required for power distribution, service, feeders, and branch circuits.

2. Compliance with applicable codes, standards, and regulations for conductor and cable installations, including local and regional requirements.

1.2 RELATED SECTIONS

26 05 26 – Grounding and Bonding for Electrical Systems.

26 05 33 – Raceways and Boxes for Electrical Systems.

26 05 00 – Common Work Results for Electrical.

1.3 REFERENCES

A. UL 83 – Thermoplastic-Insulated Wires and Cables.

B. UL 486 – Wire Connectors and Soldering Lugs for Use with Copper Conductors.

C. ICEA S-95-658 – Standard for Nonshielded Power Cables Rated 2000 Volts or Less.

D. NFPA Standards:

1. 70 National Electrical Code.

1.4 SUBMITTALS

A. Field Test Data: Megohmmeter test data for circuits under 600 volts.

B. Manufacturer's product data sheets and installation guidelines for all cables and conductors used in the project.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has successfully completed installations similar in material, design, and extent to those indicated for this Project.

B. Regulatory Requirements: Comply with NEC, local codes, and authorities having jurisdiction for electrical installations.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Building Conductors: Copper, 600 volt insulation, THW.

B. Branch Circuit Conductors and All Conductors #3 AWG and Smaller: Copper, with TW, THHN, or THWN2insulation #10 AWG and smaller, and THW larger than #10 AWG, where ambient temperature conditions exceed 140 deg. F:

1. Size all conductors; NFPA 70.
2. Minimum size to be #12 AWG.
3. Stranded conductors for #8 AWG and larger.
4. For outlets to fixtures, and in fixture channels (in dry areas); THHN insulated conductor.
5. In damp locations, under slabs, on exterior provide THWN-2.

C. Fire Alarm System Conductors: Cross-linked thermosetting polyethylene (RW90 X-link) type insulating.

D. Provide permanent plastic name-tag indicating load feed.

E. Use type XHHW-2 conductors for water pumping and regulator stations.

F. Variable Frequency Drives: Provide wire types as required by manufacturer and as specified by ENGINEER.

G. Cable Supports: OZ cable supports for vertical risers, type as required by application.

H. Select cables and conductors that meet applicable environmental standards (e.g., RoHS, REACH) and that minimize the use of hazardous substances.

2.1 COLOR AND CODING OF CONDUCTORS

A. 120/208 volt and 277/480 volt as follows:

Table 1 – Color Coding of Conductors

120/208 volt	277/480 volt
A Phase — Black	A Phase — Brown
B Phase — Red	B Phase — Orange
C Phase — Blue	C Phase — Yellow
Neutral — White	Neutral — Grey

Ground — Green	Ground — Green Stripe

PART 3 - EXECUTION

3.1 INSTALLATION

A. NFPA 70.

B. Make conductor length for parallel feeders identical.

C. Lace or clip groups of feeder conductors at distribution center, pull-boxes, and wireway. Neatly arrange wiring within cabinets, junction boxes, fixtures, etc.

D. Provide copper grounding conductors and straps.

E. Install wire and cable in code conforming raceway.

F. Use non-detrimental wire pulling lubricant for pulling No. 4 AWG and larger wire.

G. Install wire in conduit runs after concrete and masonry work is complete and after moisture is swabbed from conduits.

H. Color code conductors to designate neutral conductor and phase.

I. Furnish necessary reels, reel jacks, and other pulling aids required to prevent damage to wires and cable.

J. Splicing:

1. Install wires and cables continuous without splices from sources of supply to distribution equipment and from source of supply to motor, lighting, or power outlet.

2. Do not use pull boxes for making splices.

3. Do not install splices in conduits.

K. Use of cable with more conductors than specified; CONTRACTOR’s option. When done, tape off and labeled extra conductors as spares.

3.2 CONDUCTOR CONNECTIONS

A. Use approved pressure type solderless connectors and lugs for service entrance, feeder, equipment connections and terminal posts.

B. Use connectors of a type compatible to conductors, locations, and load.

C. Make neutral connection and taps individually in order to prevent the possibility of an "open-neutral."

D. Make branch circuit connections with UL approved solderless connectors. Do not depend solely upon a single insulating material to secure connection as well as to insulate it.

E. After first either silverplating the bars or applying suitable non-oxidizing agents, bolt buss bar connections with adequate nonferrous bolts, washers, and lockwashers.

F. Insulate joints and taps with patented or molded plastic insulators. Use tapes compatible with conductor jackets, temperature, and other conditions.

3.3 SPECIAL WIRING

A. Special Systems: Furnish and install equipment, materials, labor, services, and accessories required for completion of any special systems of an electrical nature, but not classified otherwise herein, that may be indicated. Applicable portions of NFPA 70 also apply.

3.4 HAZARDOUS AREAS

A. Comply with NFPA 70 when installing wiring, fixtures, and equipment in locations classified as ”Hazardous Locations."

B. Ensure that all electrical components installed in hazardous areas are suitable for their intended use, properly rated, and certified for use in such environments.

3.5 AFTER INSTALLATION TEST FOR CABLE 600 VOLTS AND BELOW

A. Before energization, test cable and wire for continuity of circuit and for short circuits. Megger all circuits of 100 amp and greater rating.

B. Correct malfunctions.

C. Submit record of mega ohm meter readings to ENGINEER.

D. Provide documentation of any corrective actions taken during the testing process to ensure proper functioning of the electrical system.

3.6 IDENTIFICATION OF FEEDERS

A. Affix a marker stamped or embossed on each cable at each entry to and exit for each manhole, pullhole, pullbox, cable tray switchgear and switch, identifying circuit; i.e. "MCCI", "PANEL L" "NO 1" etc.

B. Identification letters to be 1/8 inch size minimum.

C. Markers to be rigid, noncorrosive, attached to feeder cables with feeder identification.

D. Nylon straps to be used to tie the markers.

3.7 FIELD QUALITY CONTROL

A. Inspection: Inspect all installed conductors and cables for compliance with the specifications.

B. Testing: Perform continuity, insulation resistance, and voltage drop tests on completed installations.

3.8 CLEANING

A. Clean the interior of the piping system before commissioning.

B. Flush the system with clean water to remove any debris or contaminants.

3.9 PROTECTION

A. Protect installed pipes from damage during the remainder of construction activities.

3.10 DOCUMENTATION

A. Protect installed conductors and cables from damage during the remainder of construction.

B. Replace damaged conductors or cables prior to project completion.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V or less.
2. Connectors, splices, and terminations rated 600 V or less.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.
2. Note to Designer: This is required for projects with federal funds.

1.2 RELATED SECTIONS

07 84 13 **–** Penetration Firestopping

26 05 33 **–** Raceway and Boxes for Electrical Systems

26 05 04 **–** Sleeves and Sleeve Seals for Electrical Raceways and Cabling

26 05 53 **–** Identification for Electrical Systems

1.3 REFERENCES

A. NFPA 70

B. NEMA WC 70/ICEA S-95-658

C. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with NFPA 70.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

B. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2, Type XHHW-2 and Type SO.

C. Multiconductor Cable: Comply with NEMA WC 70 / ICEA S-95-658 for metal-clad cable, Type MC and Type SO with ground wire.

2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to authorities having jurisdiction and marked for intended location and application.

B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Provide conductors in sizes shown on the plans and as specified below.

B. Service and Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 14 AWG and smaller; stranded for No. 12 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2 for No. 1 AWG and smaller; Type XHHW-2 for No. 1/0 AWG and larger. All shall be single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2 for No. 1 AWG and smaller; Type XHHW-2 for No. 1/0 AWG and larger. All shall be single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2. All shall be single conductors in raceway.

E. Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway for No.1 AWG and smaller; Type XHHW-2, single conductors for No. 1/0 AWG and larger; Armored cable, Type AC; Metal-clad cable, Type MC.

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2 for No. 1 AWG and smaller; Type XHHW-2 for No. 1/0 AWG and larger. All shall be single conductors in raceway.

3.3 BRANCH CIRCUITS

A. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2 for No. 1 AWG and smaller; Type XHHW-2 for No. 1/0 AWG and larger. All shall be single conductors in raceway.

B. Branch Circuits:

1. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2 for No.1 AWG and smaller; Type XHHW-2 for No. 1/0 AWG and larger. All shall be single conductors in raceway.

2. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2. All shall be single conductors in raceway.

3. Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway for No. 1AWG and smaller; Type XHHW-2, single conductors for No. 1/0 AWG and larger; Multi-Conductor, PVC-sheathed Tray Cable, Type TC; Armored cable, Type AC Metal-clad cable, Type MC.

C. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

D. Multi-Wire Branch Circuits: Install no more than three circuits in a raceway, unless specifically shown otherwise.

E. Neutral Conductors: Provide one neutral conductor for each phase conductor. Shared neutral conductors are not allowed.

F. Minimum Branch Circuit Conductor Size: Provide the following minimum sizes for distances listed on 20A branch circuits to prevent excessive voltage drop. The circuit length shall be measured along the length of the conductor from the circuit breaker in the panelboard to the last device on the circuit. Increase raceway size to comply with conductor fill requirements of NFPA 70.

1. Branch Circuit Voltage of 120V:

a. Circuit lengths less than 70 feet: Provide minimum #12 AWG conductor size.

b. Circuit lengths between 70 feet and 110 feet: Provide minimum #10 AWG conductor size.

c. Circuit lengths between 110 feet and 170 feet: Provide minimum #8 AWG conductor size.

d. Circuit lengths greater than 170 feet: Perform voltage drop calculations and provide conductor size to keep branch circuit voltage drop less than 3 % with a 15 amp load.

2. Branch Circuit Voltage of 277V:

a. Circuit lengths less than 150 feet: Provide minimum #12 AWG conductor size.

b. Circuit lengths between 150 feet and 240 feet: Provide minimum #10 AWG conductor size.

c. Circuit lengths between 240 feet and 380 feet: Provide minimum #8 AWG conductor size.

d. Circuit lengths greater than 380 feet: Perform voltage drop calculations and provide conductor size to keep branch circuit voltage drop less than 3 % with a 15 amp load.

G. Fire Alarm Circuits:

1. Type THWN-2 in raceway for fire alarm power circuits, for horn circuits, and for strobe circuits.

2. Power-limited, fire-protective, signaling circuit cable in raceway for initiating loop circuits.

3. Twisted shielded pair in raceway for evacuation speakers.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, and strain relief device at terminations to suit application.

I. Class 1 Control Circuits: Type THHN-THWN, in raceway.

J. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Install all conductors and cables in raceways per Section 26 05 33 Raceway and Boxes for Electrical Systems.

C. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 Raceways and Boxes for Electrical Systems prior to pulling conductors and cables.

D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 04 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.

   a. Fueling equipment.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

   a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

   b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.

2. Results that comply with requirements.

3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

3.10 OWNERS QUALITY ASSSURANCE

A. OWNER’s independent commissioning and witnessing agency will provide the following witnessing and/or review services:

1. Witness all infrared scanning.

2. Review all test and inspection reports.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.

2. Ground bonding common with lightning protection system.

3. Foundation steel electrodes.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.

a. Note to Designer: This is required for projects with federal funds.

1.2 RELATED SECTIONS

01 78 23 Operation and Maintenance Data

26 05 43 Underground Ducts and Raceways

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. NFPA Standards 70: National Electrical Code.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Informational Submittals:

1. Qualification Data: For testing agency and testing agency's field supervisor.

2. Field quality-control reports.

a. Test procedures and testing equipment used.

b. Test results that comply with requirements.

c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Closeout Submittals:

1. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified, including the following:

a. Test wells

b. Ground rods

c. Ground rings

d. Grounding arrangements and connections for separately derived systems

2. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

a. Items specified in Section 01 78 23 Operation and Maintenance Data

b. In addition to items specified in Section 01 78 23 Operation and Maintenance Data, include the following:

1) Instructions for periodic testing and inspection of grounding features at test wells based on NFPA 70B (Standard for Electrical Equipment Maintenance).

a) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.

b) Include recommended testing intervals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of InterNational Electrical Testing Association (NETA) or a National Recognized Testing Laboratory (NRTL).

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in National Fire Protection Association (NFPA) 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with Underwriters Laboratories (UL) 467 for grounding and bonding materials and equipment.

D. Comply with NFPA 70 for grounding and bonding of electrical systems.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, ¼ inch (6 mm) in diameter.

5. Bonding Conductor: No.4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, ¼ by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; ¾ inch by 10 feet (19 mm by 3 m).

PART 3 – EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum.

1. Bury at least 35 inches (900 mm) below grade.

2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.

2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses. Locate main bonding jumper at service entrance equipment for testing purposes.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode(s) shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with Institute of Electrical and Electronics Engineers (IEEE) C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits
2. Lighting circuits
3. Receptacle circuits
4. Single-phase motor and appliance branch circuits
5. Three-phase motor and appliance branch circuits

6. Flexible raceway runs

7. Armored and metal-clad cable runs

8. Baggage X-Ray and/or Scanning Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying scanning equipment

B. Equipment in Hazardous Locations: Wiring and equipment in Class I, Division 1 and 2 hazardous locations shall be grounded as specified in NEC Article 250 and in accordance with the requirements of NEC Article 501.30(A) and (B).

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

G. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

H. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ¼ -by- 4 -by-12-inch (6.3-by-100-by-300-mm) grounding bus.

3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole.

E. Handholes are specified in Section 26 05 43 Underground Ducts and Raceways for Electrical systems, and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

F. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

G. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

H. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

I. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

J. Bonding of Exposed Structural Metal: Bond all exposed structural metal that is not grounded to the service equipment enclosure. The points of attachment of the bonding jumpers shall be accessible.

K. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 4 /0 AWG for ground ring and for taps to building steel.

2. Bury ground ring not less than 36 inches (900 mm) from building's foundation.

L. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 2 AWG.

1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.

2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.7 TRADE CONTRACTOR QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.

3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

5. Substations and Pad-Mounted Equipment: 5 ohms.

6. Manhole Grounds: 10 ohms.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify ENGINEER promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.

1.2 RELATED SECTIONS

07 84 13 – Penetration Firestopping

26 05 04 – Sleeves and Sleeve Seals for Electrical Raceways and Cabling

26 05 34 – Electrical Boxes and Fittings

26 05 43 – Underground Ducts and Raceways for Electrical Systems

31 23 16 – Excavation

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

2. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

    a. Custom enclosures and cabinets.

    b. For handholes and boxes for underground wiring, including the following:

        1) Duct entry provisions, including locations and duct sizes.

        2) Frame and cover design.

        3) Grounding details.

        4) Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

        5) Joint details.

3. Samples: For the following raceway components:

    a. PVC-Coated Steel Conduit

    b. Rigid nonmetallic conduit (RNC)

    c. Expansion fittings

    d. Cast-metal outlet and device boxes

B. Informational Submittals:

1. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

    a. Structural members in paths of conduit groups with common supports.

    b. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

2. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

        1) The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event."

    b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

d. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

3. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Installer Qualifications: An experienced installer with a minimum of 5 years of experience working on projects of similar scale and complexity.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

C. EMT: Electrical Metallic Tubing.

D. FMC: Flexible Metal Conduit.

E. LFMC: Liquid-Tight Flexible Metal Conduit.

F. PVC: Polyvinyl Chloride.

G. RNC: Rigid Nonmetallic Conduit.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 3/4 inch.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.

2. Coating Thickness: 0.040 inch (1 mm), minimum.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. FMC: Zinc-coated steel, FS-WW-C-566 and UL 1.

H. LFMC: Single strip, flexible continuous, interlocked, and double-wrapped steel, galvanized inside and outside, coated with liquid-tight jacket of flexible PVC et and complying with UL 360.

I. Liquid-Tight Flexible Metal Conduit Fittings: FS-W-F-406, Type 1 Class 3, Style G.

J. Metal Conduit Fittings: Comply with NEMA FB 1 and UL 514B, Type 1, Class 1, Style A, FS W-F-406.

K. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

L. EMT Fittings: Provide insulated throat non-indenter type malleable steel fittings; concrete tight where required by application. Install OZ type B bushings on conduits 1-1/4 inches and larger.

M. GRC and IMC Fittings: Provide fully threaded malleable steel couplings; raintight and concrete tight where required by application. Provide double locknuts and metal bushings at conduit termination, use OZ type B bushings on conduits I-1/4 inch and larger.

N. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

O. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

P. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

Q. Fittings for PVC-Coated Conduit: Include separate sealing sleeves for each conduit entry.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. Fittings for RNC: Comply with NEMA TC 3; match to conduit type and material.

D. RNC: Comply with UL 651A and be rated for continuous use in direct sunlight and underground applications.

E. Underground PVC Plastic Utilities Duct: NEMA TC6, Type I for encased burial in concrete, Type II for direct burial.

1. Duct Fittings: NEMA TC9, match to duct type and material.

2.3 CONDUIT, TUBING, AND DUCT ACCESSORIES

A. Types and sizes, and materials, complying with manufacturer's published product information, that mates and matches conduit and tubing. Provide manufactured spacers in all duct bank runs.

2.4 LOCKNUTS, BUSHINGS, CONNECTORS, COUPLINGS, AND SUPPORTS

A. General: Provide malleable bushings, except that plastic bushings may be used in lieu of phenolic-lined malleable bushings where "insulating bushings" are required.

B. Provide "double-lockout" system (two (2) locknuts) throughout, each being tightened wrench tight as to effectively bond outlet box or cabinet to conduit.

C. Sealing Bushing: OZ Type FSK, WSK, or CSMI as required by application. Provide OZ type CSB internal sealing bushings.

D. Provide insulated-through type ground bushing of the malleable type.

E. Provide connectors or couplings that are proper for the conduit they are used with. Make watertight when required.

F. Provide cadmium plated or galvanized fittings.

G. Provide fittings with die-cut threads unless approved otherwise.

H. EMT connectors used with #4 and larger cable shall have throat liners of suitable plastic insulation.

2.5 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 for indoor dry installations and 3R for outdoor and wet or damp location, unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Retain one or more options in "Wireway Covers" Paragraph below. If retaining more than one type, indicate locations of each type on Drawings.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1; double-gang, minimum 4-11/16" square boxes with single or double-gang mud ring appropriate for the device and wall plate. Comply with UL 514A.

1. Boxes in concrete and block walls may be single-gang.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

D. Metal Floor Boxes:

1. Cast or sheet metal, fully adjustable, rectangular.

2. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Nonmetallic Floor Boxes: Nonadjustable, rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions unless otherwise indicated: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 for indoors; Type 3R for outdoor, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1 for indoors; Type 3R for outdoor, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

M. Seismic Requirements: Ensure boxes, enclosures, and cabinets meet seismic requirements as per local codes and guidelines.

PART 3 - EXECUTION

3.1 PREPARATION

A. Locate and preserve utilities, Section 31 23 16 “Excavation.”

B. Excavate, Section 31 23 16 “Excavation.”

3.2 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: Rigid galvanized steel conduit.

2. Concealed Conduit, Aboveground: Rigid steel conduit.

3. Underground Conduit: RNC, Type EPC-40-PVC:

a. Concrete-encased where indicated.

b. Provide wrapped rigid steel conduit for the following conditions:

1) Penetrations through foundation walls.

2) Bends greater than 22 degrees.

3) Stub ups, or where underground conduits otherwise become exposed.

c. Provide OVC-coated rigid steel conduit for the following conditions:

1) Penetrations through foundation walls.

2) Bends greater than 22 degrees.

3) Stub-ups, or where underground conduits otherwise become exposed. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

5. Application of Handholes and Boxes for Underground Wiring:

a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.

b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.

c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

B. Indoors: Apply raceway products as specified below unless otherwise indicated.

1. Non-Hazardous Locations:

a. Exposed, Not Subject to Physical Damage: EMT.

b. Exposed and Subject to Physical Damage: Rigid steel conduit.

c. Raceway locations include the following:

1) Loading dock.

2) Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

3) Mechanical rooms.

C. Warehouse and storage areas.

1. Concealed in Ceilings and Interior Walls and Partitions: EMT.

2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.

3. Damp or Wet Locations: GRC.

4. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.

5. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

6. All Conditions: Threaded GRC.

7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC listed for use in hazardous locations.

8. Boxes and Enclosures: Listed for use in Class 1 Division 1 hazardous locations.

D. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

E. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.

4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

F. Install surface raceways only where indicated on Drawings.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Do not install conduits embedded in elevated slabs.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3- m)intervals.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by ENGINEER for each specific location.

5. Change to rigid steel conduit before rising above the floor.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. At hazardous location boundaries and where entering boxes and enclosures in hazardous locations as required by NEC (NFPA 70) Article 501.

3. Where otherwise required by NFPA 70.

S. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

T. Expansion-Joint Fittings:

1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

U. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi recessed luminaires, equipment subject to vibration, noise transmission, or movement, and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

W. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

X. Boxes in stud walls: Do not install boxes back-to-back in stud walls. Allow one stud separation or 24" minimum. Where this is not possible, then provide boxes with UL- listed fire rated and sound rated wrapping.

Y. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

Z. Locate boxes so that cover or plate will not span different building finishes.

AA. Support boxes of three gangs or more from more than one side by panning two framing members or mounting on brackets specifically designed for the purpose.

BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

CC. Set metal floor boxes level and flush with finished floor surface.

DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.Install conduit concealed in all areas, excluding mechanical and electrical rooms, connections to motors, and connections to surface cabinets.

EE. For exposed runs attach surface-mounted conduit with clamps.

FF. Coordinate installation of conduit in masonry work.

GG. Unless indicated otherwise, do not install conduit larger than 2-1/2 inches in concrete slabs. Provide a minimum concrete cover around conduits of two (2) inches.

HH. Install conduit free from dents and bruises. Plug ends to prevent entry of dirt and moisture.

II. Clean out conduit before installation of conductor.

JJ. Alter conduit routing to avoid structural obstructions, minimizing crossovers.

KK. Fill end of conduit with fiberglass where conduits leave heated area and enters unheated area.

LL. Provide flashing and pitchpockets, making watertight joints where conduits pass through roof or waterproofing membranes.

MM. Install UL approved expansion fittings complete with grounding jumpers where conduits cross building expansion joints. Provide bends or offsets in conduit adjacent to building expansion joints where conduit is installed above suspended buildings.

NN. Route all exposed conduits parallel or perpendicular to building lines.

OO. Make interconnections between different types of raceways with manufactured fittings approved by UL.

PP. Size raceways; NFPA 70 tables. Do not reduce from any size indicated.

QQ. Do not exceed sizes permitted in slabs or walls.

1. Do not exceed the number of bends allowed in conduit by NFPA 70.

RR. Make joints wrench tight or otherwise with minimum resistance to the flow of fault currents.

SS. Use furred spaces and chases to an advantage in concealing conduits.

TT. Make field bends only where needed and then carefully to minimize wire pulling tensions and for best appearance in exposed runs.

UU. Test conduit runs with lignum vitale ball (mandrel) of 85 percent of conduit diameter.

VV. Cut conduit with hacksaw or other approved pipe cutting tool and ream ends to clean out all burrs before connecting.

WW. Keep conduits at least six (6) inches away from steam or hot water pipes, breaching, and boilers, but in no case permit conductors to reach higher than rated temperatures. Avoid traps in runs and slope conduit to drain.

XX. Fasten raceways securely in place. Firmly fasten conduit within three (3) feet of each outlet, junction box, cabinet, or fitting. Support metallic conduit, rigid (heavy wall) and EMT at least every 10 feet. Support rigid nonmetallic conduit in strict accordance with NFPA 70. Use raceway fasteners designed for the purpose.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 04 Sleeves and Sleeve Seals for Electrical Raceways and Cabling.

B. Install sleeves and sleeve seals at penetrations of interior floor and wall assemblies where required for maintaining fire rating or soundproofing. Comply with requirements in Section 26 05 04 Sleeves and Sleeve Seals for Electrical Raceways and Cabling.

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 Penetration Firestopping.

B. Install firestopping at penetrations of non-fire-rated floor and wall assemblies where required for maintaining acoustic separation or where otherwise specified.

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

B. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

1. Use protective coverings and barriers as necessary to prevent damage to electrical equipment and raceway systems during construction.

3.7 SPECIAL CONDUIT FITTINGS

A. Use special conduit fittings as required or indicated. Use UL approved fittings suitable for location and usage made.

B. At expansion joints use special fittings if cast in concrete slabs.

C. Building Expansion Joints: Where surface conduits, raceways, panels, or light fixtures, span building expansion joints, make satisfactory arrangements to provide the movement provided for in building structure plus or minus nominal joint width.

3.8 PULL BOXES, WIREWAYS, AND GUTTERS

A. Furnish as indicated, plus any such items required to assemble conduits and other raceways. Provide Section 26 05 34 pull boxes as dictated by wire pulling requirements. Unless indicated otherwise face into secondary or unfinished rooms.

B. Construction: Code gage galvanized sheet steel and sized strictly in conformance with NFPA 70 requirements.

C. Finish: Free of burrs, sharp edges, unreamed holes, and sharp—pointed screw or bolts.

D. Coating: When mounted direct to concrete or masonry walls that are below grade or where there will be sweating or other moisture present on wall surface, coat backs of boxes with a heavy coat of black asphalt paint before mounting.

E. Protection: Adequate provisions for preventing damage to conductors either during pulling in or from weights and tensions when in place.

F. Weatherproof, rain-tight, or special type when indicated or when required by NFPA 70.

3.9 ANCHORS, FASTENERS, AND MISCELLANEOUS SUPPORTS

A. Use compatible anchors in roof or ceiling slabs of concrete from which a load is suspended and anchors used to fasten heavy equipment without lead in their construction.

B. Make exposed conduit fastenings with one-piece, malleable conduit clamps. Two hole, galvanized sheet metal pipe straps may be used on all concealed installations.

C. Use companion bases or backs with conduit clamps when conduit is exposed to weather or continuous moisture.

D. Use ring type hangers on individual runs of conduit three (3) inches and larger if suspended, complete with threaded rods. Use adjustable turnbuckles when specified or otherwise as an option.

E. Support multiple runs of suspended conduits from trapeze style hangers suspended with rigid threaded steel rods and with suitable conduit clamps or straps of the same make as cross channels used.

F. Mount multiple runs of conduit on ceiling or wall surfaces.

G. Do not hang or support electrical equipment and materials from roof decks.

3.10 COLOR CODING, EXPOSED CONDUIT

A. Provide color bands 1 inch wide for conduits up to two (2) inches in diameter and one-half the conduit diameter for large conduits applied at panel and pull-box locations within each room and 500 feet on centers within an area.

B. Color Banding:

Table 1 – Color Banding

Units	Color Band
120/208 Volt	Gray
347/600 Volt	Sand Fire
Alarm	Red
Telephone	Blue
Intercommunication and Sound	Yellow
Clocks	Green
Television	Rust
Low Voltage Switching	Black

C. Nonmetallic Pressure Piping Label: When applicable, engraved plastic laminate, label permanently affixed to main electrical meter panel reading "THIS STRUCTURE HAS A NONMETALLIC PRESSURE PIPING SERVICE."

END OF SECTION

SECTION 26 05 34

ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Junction boxes, pull boxes, fittings.

1.1 RELATED SECTIONS

05 05 23 **–** Metal Fastenings

1.2 REFERENCES

A. NEMA Standards:

1. OS 1 Sheet—Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

2. OS 2 Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.

B. NFPA Standards:

1. 70 National Electric Code.

C. Utah Building Codes and Regulations: Applicable codes and regulations pertaining to electrical installations in railways.

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70 as applicable for installation of electrical boxes and fittings.

B. Comply with NEMA OS 1 and NEMA OS 2 as applicable for outlet boxes, device boxes, covers and box supports.

C. Provide electrical boxes and fittings which have been UL-listed and labeled.

D. Personnel and Installer Qualifications: Employ personnel and installers with appropriate qualifications and experience in railway electrical installations.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 INTERIOR OUTLET BOXES

A. One piece, galvanized flat rolled sheet steel, cast iron or cast aluminum outlet wiring boxes, of types shapes and sizes, including box depths, to suit each respective location and installation. If of aluminum, essentially "copper free". Do not use on conduits of dissimilar metals, except with ENGINEER’s knowledge.

B. Construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box and covers and wiring devices.

C. Minimum depth 1-1/4 inches or 2-1/8 inches depth for boxes with three (3) or more conduit entries.

D. Use in combination with factory or field bends when indicated or advised. Complete outlet bodies with mounting brackets, hangers, extension rings, fixture studs, cable clamps, metal straps, gaskets, cover, hubs, reducers, and other accessories.

E. Tamper-Resistant and Impact-Resistant Materials: Use materials suitable for railway installations, ensuring durability and resistance to vandalism.

2.2 WEATHERPROOF OUTLET BOX

A. Corrosion-resistant cast-metal of types, shapes and sizes (including depth) required.

B. Threaded conduit ends, cast-metal face plates with spring hinged waterproof caps suitably configured for each application, with face plate gaskets and corrosion-resistant fasteners.

C. Minimum IP Rating: IP66 - Ensure weatherproof outlet boxes have a minimum ingress protection rating of IP66 to provide resistance against dust, water, and other environmental conditions.

2.3 JUNCTION AND PULL BOXES

A. Building Structure Type: Code-gage sheet steel with screw-on covers; of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with galvanized steel Section 05 05 23 “nuts, bolts, screws and washers” conforming with Section 05 05 23 “Metal Fastenings.”

B. Buried Type: Unless shown otherwise on drawings, plastic body and cover, or pre-cast concrete with screw-on cast iron covers; of types, shapes and sizes to suit each respective location and installation; equipped with stainless steel nuts, bolts, screws and washers.

C. Vibration Resistance and Durability: Specify requirements for junction and pull boxes to meet or exceed IEC 60068-2-6 standard for vibration resistance and ANSI/ISA 60079-0 standard for durability, to withstand vibrations and dynamic loads in railway installations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate installation of electrical boxes and fittings with wire, cable and raceway installation work.

B. Provide knockout closures to cap unused knockout holes where blanks have been removed.

C. Coordination with Other Trades: Coordinate electrical installations with mechanical and civil works to ensure proper integration of systems in railway settings.

3.2 INSTALLATION

A. Install where indicated, complying with manufacturer's written instruction, applicable requirements of NFPA 70 and NEMA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Install coverplates for all boxes; weatherproof outlets for interior and exterior locations exposed to weather or moisture.

C. Install boxes and fittings to ensure ready accessibility of electrical wiring. Install recessed boxes with face of box or ring flush with adjacent surface.

D. Fasten boxes rigidly to substrates or structural surfaces to which attached, or solidly embed boxes in concrete or masonry. Use bar hangers for stud construction. Use of nails for securing boxes is prohibited. Set boxes on opposite sides of common wall with minimum 10 inches of conduit between them.

E. Inspection, Maintenance, and Documentation: Regularly inspect, maintain, and document electrical boxes and fittings to ensure long-term safety and performance in railway installations.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and duct banks, and in single duct runs.

2. Handholes and boxes.

3. Manholes.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.

1.2 RELATED SECTIONS

03 30 00 – Cast-in-Place Concrete

03 30 10 – Concrete Placement

26 05 04 – Sleeves and Sleeve Seals for Electrical Raceways and Cabling

26 05 53 – Identification for Electrical Systems

31 23 16 – Excavation

31 05 13 – Common Fill

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For the following:

a. Duct-bank materials, including separators and miscellaneous components.

b. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.

c. Accessories for manholes, handholes, pull boxes, and other utility structures.

d. Warning tape.

e. Submittal shall be separate from requirements for communication systems.

2. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

a. Precast or Factory-Fabricated Underground Utility Structures:

1) Include plans, elevations, sections, details, attachments to other work, and accessories.

2) Include duct entry provisions, including locations and duct sizes.

3) Include reinforcement details.

4) Include frame and cover design and vault frame support rings.

5) Include Ladder details.

6) Include grounding details.

7) Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

8) Include joint detail.

b. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

1) Include dimensioned plans, sections, and elevations, and fabrication and installation detail.

2) Duct entry provisions, including locations and duct sizes.

3) Frame and cover design and manhole frame support rings.

4) Ladder details.

5) Grounding details.

6) Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

7) Joint details.

B. Informational Submittals:

1. Concrete mix designs. Provide product requirement for the following:

a. Concrete-encased duct banks.

b. Flowable backfill.

2. Product Certificates: For concrete and steel used in precast concrete vaults and handholes, as required by ASTM C 858.

3. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

4. Source quality-control reports.

5. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Testing agency qualifications: Qualified according to ASTM E 329 for testing indicated.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITION

A. RNC: Rigid nonmetallic conduit

B. ASTM: American Society for Testing and Materials

C. ANSI: American National Standards Institute

D. NFPA: National Fire Protection Association

E. NEMA: National Electrical Manufacturers Association

F. UL: Underwriters Laboratories

G. NRTL: Nationally Recognized Testing Laboratory

H. AASHTO: American Association of State Highway and Transportation Officials

I. SCTE: Society of Cable Telecommunications Engineers

J. NIST: National Institute of Standards and Technology

1.8 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by OWNER or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify OWNER's Representative no fewer than seven days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without OWNER's Representative's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.10 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by ENGINEER.

PART 2 – PRODUCTS

2.1 GENERAL REQUIRMENTS FOR DUCTS AND RACEWAYS

A. Comply with ANSI C2.

2.2 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514b.

C. Fiberglass: Per Rocky Mountain Power requirements, UL 2515, fiberglass conduit and sweeps must be black with three red stripes to identify electric conductors inside.

2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Underground Plastic Utilities Duct: NEMA TC 2, UL 651, ASTM F 512, Type EPC-40-PVC, with matching fittings complying with NEMA TC 3 by same manufacturer as the duct.

B. Conduit Sweep Applications:

1. Medium voltage, three phase primary: per Rocky Mountain Power sweeps must be constructed of fiberglass. Fiberglass conduit shall meet or exceed Rocky Mountain Power's material specification ZG033 "Fiberglass Conduit."

    a. Each fiberglass sweep requires two factory-attached PVC, extra-deep, fabricated, expanded bell-ends.

    b. Fiberglass sweeps must be certified by a NRTL.

2. Field formed sweeps from straight conduit (PVC only) up to 15 degrees are allowed as long as the mandrel can be pulled through the conduit and the conduit is not damaged.

C. Duct Spacers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Insert UTA preferred manufacturers.

2. Conduit spacers of the prefabricated interlocking unit type shall be manufactured for the intended purpose. Interlocking units shall be of double wall construction made of high grade, high density polyethylene complete with interlocking cap and base pads. They shall be designed to accept No. 4 reinforcing bars installed vertically.

3. Conduit spacers of the pre-fabricated HDPE panel type shall be custom-manufactured and pre-engineered to match the specific duct bank arrangement and made of high-grade, high density polyethylene with holes for adequate concrete flow-through to avoid concrete shear point and holes for both horizontal reinforcing bars and hold-down reinforcing bars.

D. Duct Accessories:

1. Warning Tape: Underground-line warning tape specified in Section 26 05 53 "Identification for Electrical Systems."

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   1. Insert UTA preferred manufacturers.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. AASHTO approved H-20 for use un roadways or in deliberate vehicular traffic paths within parking lots.

D. AASHTO approved H-10 for use in incidental traffic, and immediately adjacent to roadways.

E. Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A153 (ASTM A153M) and ASTM A123 (ASTM A123M).

F. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

   1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

   2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

   3. Cover Legend: Molded lettering, "ELECTRIC" or "TELEPHONE" as required for each service.

   4. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.

   5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

      a. Extension shall provide increased depth of 12 inches (300 mm).

      b. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.

   6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

      a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.

b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.

c. Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.

7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size shall match fittings to duct or conduit to be terminated.

b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

9. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.

10. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.5 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C 858 and with Section 03 30 00 "Cast-in-Place Concrete."

1. Concrete shall have a minimum compressive strength of 3000 psi (20 MPa).

C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

2.6 FIBERGLASS HANDOLES AND BOXES

A. Comply with SCTE 77. Comply with tier 5 requirements (minimum) in "Underground Enclosure Application" Article.

1. Description: Factory-fabricated, molded of fiberglass-reinforced polyester resin, with frame and covers of skid-resistant cast iron. For use in landscape areas only. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

a. Color: Gray.

b. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

c. Cover: Cast-iron, weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

d. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

e. Cover Legend: Molded lettering, "ELECTRIC."

f. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

g. Handholes 36 inches wide by 30 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.7 UTILITY STRUCTURE ACCESSORIES

A. Ferrous metal hardware, where indicated, shall be hot-dip galvanized complying with ASTM A 153 (A 153M) and A 123 (A 123M).

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30Bwith milled cover-to-frame bearing surfaces; diameter, 29 inches (737 mm).

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.

a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.

b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.

c. Legend: "SIGNAL" for communications, data, and telephone duct systems.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.

C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.

   1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (32- mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.

F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

   1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1- 1/4 inches (32 mm) minimum at base.

   1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.

H. Ground connection Sleeve: 3-inch (75-mm), PVC conduit sleeve installed high on vault wall adjacent to, but not underneath, the ducts routed from the facility.

I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel- wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24 kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.

J. Cable Rack Assembly: Steel, hot-rolled, hot-dip galvanized, except insulators.

   1. Stanchions: T-section or channel; 2-1/4 inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.

   2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204 kg) minimum capacity to 20 inches (500 mm) with 250-lb (114 kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.

   3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

K. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

L. Duct-sealing for unoccupied ducts shall be Cherne “Original Gripper” style duct plugs.

M. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

N. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater. Two required.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of vaults and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

2. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 CORROSION PROTECTION

A. Aluminum shall not be installed in contact with earth or concrete.

3.2 PREPERATION

A. Coordinate layout and installation of ducts, vaults, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify ENGINEER if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of ducts and duct-bank entrances into vaults, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to vaults and handholes, and as approved by ENGINEER.

3.3 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables over 600 V: RNC, NEMA Type EPC-40-PVC, with fiberglass elbows.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

C. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, unless otherwise indicated.

D. Underground Ducts Crossing Paved Paths Walks and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.4 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Pull Boxes for 600 V and Less.

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.

4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13,345-N) vertical loading.

5. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast or cast-in-place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H- 10 load rating according to AASHTO HB 17.

3.5 EARTHWORK

A. Excavation and Backfill: Comply with Section 31 23 16 "Excavation" and 31 05 13 “Common Fill” but do not use heavy-duty, hydraulic-operated, compaction equipment.

1. Backfill material in areas with ground improvement under buildings shall comply with the requirements in “Aggregate Backfill Material."

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

D. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.6 DUCT INSTALLATION

A. Install ducts according to NEMA TCB 2.

B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 12.5 feet (4 m), both horizontally and vertically, at other locations, unless otherwise indicated.

D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

E. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

   1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.

   2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.

   3. Grout end bells into structure walls from both sides to provide watertight entrances.

F. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 26 05 04 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

1. All new conduits, raceways, and cables in all manholes, vaults, and handholes shall be sealed where work is to be performed. Existing raceways and cables shall be sealed where existing raceways are utilized. New Rocky Mountain Power ducts shall be sealed per Rocky Mountain Power requirements prior to turnover of vaults or handholes to Rocky Mountain Power.

    a. Conduits containing single cables shall be sealed with simplex duct plugs or Duraline S-50 duct seal per manufacturer recommended installation procedures.

    b. Spare ducts shall be sealed with plugs listed for power duct sealing.

    c. Conduits containing irregular shaped innerduct, cables, or other items that cannot be sealed with a pre-manufactured seal shall be sealed with Duraline S-50 putty sealant.

H. Pulling Cord: Install 1200-lbf- (445-N-) test nylon cord in ducts, including spares.

I. Concrete-Encased Ducts: Support ducts on duct separators.

1. Excavate trench bottom to provide firm and uniform support for duct bank.

    a. Backfill material in areas with ground improvement under buildings shall comply with the requirements in concrete Section "Aggregate Backfill Material."

2. Width: Excavate trench 12 inches (300 mm) wider than duct bank on each side.

3. Duct banks shall be installed so that the top of the concrete encasement is not less than 30 inches (750 mm) below finished grade where installed in paved and unpaved areas, unless otherwise shown on the plans.

4. Support underground conduits on duct bank separators coordinated with duct size, duct spacing, and outdoor temperature.

5. Separator Installation: Spacers shall be installed at 5-foot intervals, to prevent sagging and deforming of ducts. Secure separators to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts. Rocky Mountain Power conduit shall be spaced a minimum of 12” from all other electrical services.

7. Elbows: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run. All underground rigid steel conduit shall have two-layers of half-lap corrosion resistant tape.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.

    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

8. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

9. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

J. Concrete

1. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover at top and bottom, and a minimum of 3 inches (50 mm) on each side of duct bank.

2. Concreting Sequence: Pour each run of envelope between vaults or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.

    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (15-mm) reinforcing-rod dowels extending a minimum of 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Comply with requirements in Section 03 30 10 “Concrete Placement”. Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Red concrete dye shall be sprinkled onto the concrete and troweled into the top layer of concrete to achieve a uniform red color.

K. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.

2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.

3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 31 23 23 "Backfilling for Structures" for pipes less than 6 inches (150 mm) in nominal diameter.

4. Install backfill as specified in Section 31 23 16 "Excavation."

5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process.

L. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Section 31 23 26 "Compaction."

1. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.

2. Depth, 600V and Below: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.

3. Depth, Above 600V: Install top of duct bank at least 48 inches (1200 mm) below finished grade unless otherwise indicated.

4. Set elevation of bottom of duct bank below the frost line.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.

    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

6. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

M. Backfilling for Duct Banks.

1. After the concrete has cured, the remaining trench shall be backfilled and compacted in accordance with Section P-152 “Excavation and Embankment”, except that the material used for backfill shall be select material not larger than 4 inches in diameter. In addition to the duct banks installed under pavement, one moisture/density test per lift shall be made for each 250 linear feet of duct bank or one work period’s construction, whichever is less.

    a. Backfill material in areas with ground improvement under buildings shall comply with the requirements in Section pertaining to "Aggregate Backfill Material."

2. Flowable backfill may alternatively be used on approval.

3. Trenches shall not contain pools of water during backfilling operations.

4. The trench shall be completely backfilled and tamped level with the adjacent surface except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

5. Any excess excavated material shall be removed and disposed of in accordance with instructions issued by the ENGINEER.

N. Backfilling for Conduits.

1. For conduits, concrete encasement with 8 inches of sand (loose measurement) shall be placed below the conduits and carefully tamped around and over duct bank with hand tampers. The remaining trench shall then be backfilled and compacted in accordance with Section pertaining to “Subbase Course”, except that material used for backfill shall be select material not larger than 4 inches (100 mm) in diameter.

    a. Backfill material in areas with ground improvement under buildings shall comply with the requirements in Section pertaining to "Aggregate Backfill Material."

2. Trenches shall not contain pools of water during backfilling operations.

3. The trench shall be completely backfilled and tamped level with the adjacent surface except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

4. Any excess material shall be removed and disposed of in accordance with instructions issued by the ENGINEER.

3.7 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.

2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches (38 to 50 mm) thick, arranged as indicated.

3. Cast-in-place concrete, formwork, and reinforcement are specified in Section 03 30 00 "Cast in Place Concrete."

B. Precast Concrete Handhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.

2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No.4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

4. Provide 4,000 psi at 28 day strength concrete with steel reinforcement.

C. Elevations:

1. Install handholes with bottom below the frost line.

2. Vault roof: Install with rooftop at least 15 inches (375 mm) below finished grade.

3. Vault Frame: IN paved areas and trafficways, set frames flush with finished grade. Set other vault frames 1 inch (25mm) above finished grade.

4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Vault Access: Circular opening in vault roof; sized to match cover size.

1. Install chimney, constructed of precast concrete collars and rings, to support cat-iron frame to connect cover with vault roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure. Coordinate all hardware with Rocky Mountain Power in medium voltage power vaults.

G. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 07 13 53 "Elastomeric Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

H. Field-Installed Bolting Anchors in Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

I. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems." Connections to grounding systems for Rocky Mountain Power Structures shall be by Rocky Mountain Power personnel.

3.9 TRADE CONTRACTOR'S QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 OWNERS'S QUALITY ASSURANCE

A. OWNER's independent testing and witnessing agency will provide the following testing and/or witnessing services:

1. Witness vault and handhole grounding tests.

2. Review all test and inspection reports.

3.11 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

3.12 CORE DRILLING

A. All raceway penetrations into vaults and handholes shall be cored drilled.

END OF SECTION

SECTION 26 05 50

HORIZONTAL DIRECTIONAL DRILLING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The work specified in this section consists of furnishing and installing medium voltage conduit using the directional boring (horizontal directional drilling, HDD) method of installation. This work shall include all services, equipment, materials, and labor for the complete installation, testing, and site restoration.

1.2 RELATED SECTIONS

A. Not Applicable.

1.3 REFERENCES

A. Not Applicable.

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.

   a. Ducts: Include duct material including material type, internal and external diameters, load rating, and manufacturer installation recommendations.

   b. Fittings: Include items necessary to connect to an existing conduit system or interface for penetration through a vault wall.

2. Shop drawings:

   a. Prior to beginning of work, CONTRACTOR must submit a detailed work plan to the OWNER outlining the procedure and schedule to be used to execute the project. The work plan should include a description of all equipment to be used, down-hole tools, a list of personnel and their qualifications and experience (including back-up personnel in the event that an individual is unavailable), list of sub-contractor(s), schedule of work activity, and a safety plan.

   b. Submit for approval a pre-construction bore-log depicting the plan and profile (horizontal and vertical alignment) of the proposed bore path. The bore-log shall show all utility crossings and existing structures.

c. Record Drawings: The as-built records shall include a plan, profile (data every 25 linear feet of main, at a minimum), and all information recorded during the progress of the work, including all subsurface anomalies identified by Ground Penetrating Radar and vacuum excavation. The HDD contractor shall certify the accuracy of all as-built record drawings.

1.5 QUALITY ASSURANCE

A. The requirements set forth in this specification specify a wide range of procedural precautions necessary to insure that the very basic, essential aspects of a directional bore installation are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this specification. Adherence to the specifications contained herein, or the OWNER's approval of any aspect of any directional bore operation covered by this specification, shall in no way relieve the CONTRACTOR of their ultimate responsibility for the satisfactory completion of the work authorized under this Contract.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 PERSONNEL QUALIFICATIONS CERTIFICATION

A. Directional Boring.

1. All personnel shall be fully trained in their respective duties as part of the directional drilling crew and in safety. (Each person must have been fully trained for over 1,000 hours on all facets of directional drilling, including, but not limited to machine operations, mud mixing, locating, and material fusion.) A responsible representative who is thoroughly familiar with the equipment and type of work to be performed, must be in direct charge and control of the operation at all times. In all cases the CONTRACTOR and subcontractor supervisor must be continually present at the job site during the actual directional bore operation. The Subcontractor shall have a sufficient number of competent workers on the job at all times to insure the directional bore is made in a timely and satisfactorily manner.

B. HDPE Joining (Heat Fusion).

1. Joints between HDPE conduit cannot be made via fusion but by connecting the conduits together and splicing the insulation resistance to each other. CONTRACTOR shall order sizes and lengths as required to pull the correct length of duct.

1.8 ENVIRONMENTAL PROTECTION

A. CONTRACTOR shall place silt fence between all boring operations and any drainage, wetland, waterway or other area designated for such protection by Contract Documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or boring fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. CONTRACTOR shall adhere to all applicable environmental regulations. Fuel or oil may not be stored in bulk containers within 200 feet of any water-body, wetland or runway.

1.9 SAFETY

A. CONTRACTOR shall adhere to all applicable state, federal and local safety regulations and all operations shall be conducted in a safe manner.

PART 2 – MATERIALS

2.1 GENERAL

A. Smoothwall HDPE Conduit.

1. Conduit: Conduit shall be manufactured to NEMA TC-7 requirements. SCH 80 6-inch Diameter Smoothwall HDPE by Duraline or OWNER approved equal.

2. Minimum Wall: 0.432 inches

3. Wall Tolerance: +/- 0.034 inches

4. Average ID: 6.031 inches

5. Weight (lb/ft): 4.126

B. Joints: Unless otherwise specified, provide continuous runs between manholes.

C. Conduit Markings: Per manufacturer’s recommendations.

2.2 GENERAL BORING EQUIPMENT

A. The directional boring equipment shall consist of a directional boring rig of sufficient capacity to perform the bore and pullback the pipe, a drilling fluid mixing, delivery and recovery system of sufficient capacity to complete the drill, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be re-used, a guidance system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, trained and competent personnel to operate the system. All equipment shall be in good, safety operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of the project.

2.3 DRILLING SYSTEM

A. Drilling Rig: The directional boring machine shall consist of a power system to rotate, push and pull hollow pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the crossing. The hydraulic power system shall be self-contained with sufficient pressure and volume to power boring operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations. The rig shall be grounded during boring and pull-back operations. Sufficient spares shall be kept on hand for any break-downs which can be reasonably anticipated.

B. Bore head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and boring fluid jets.

C. Mud Motors (if required) shall be of adequate power to turn the required boring tools.

D. Drill pipe shall be constructed of high quality 4130 seamless tubing, grade D or better.

2.4 GUIDANCE SYSTEM

A. A Magnetic Guidance System (MGS) or proven gyroscopic system shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance system shall be capable of tracking at all the depths up to 80 feet and in any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). The guidance system shall be accurate to +/- 2 percent of the vertical depth of the borehole at sensing position at depths up to 100 feet and accurate within 5 feet horizontally.

B. The guidance system shall be of a proven type and shall be setup and operated by personnel trained and experienced with the system. The operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system if using a magnetic system.

C. Bore Tracking/Monitoring: At all times during the pilot bore the CONTRACTOR shall provide and maintain a bore tracking system that is capable of accurately locating the position of the drill head in the x, y, and z axis. The CONTRACTOR shall record these data at least once per drill pipe length or every 25 feet, whichever is more frequent.

D. Surface Grid Tracking System: CONTRACTOR shall monitor and record x, y, and z coordinates relative to an established surface survey benchmark. The data shall be continuously monitored and recorded at least once per drill pipe length or every 25 feet, whichever is more frequent.

E. Drilling Fluid Pressure/Flow Rates: Drilling fluid pressures and flow rates shall be continuously monitored and recorded by the CONTRACTOR. The pressures shall be monitored at the pump. These measurements shall be made during pilot bore drilling, reaming, and pullback operations.

2.5 DRILLING FLUID SYSTEM

A. Mixing System: A self-contained, closed, boring fluid mixing system shall be of sufficient size to mix and deliver boring fluid composed of bentonite clay, potable water and appropriate additives. Mixing system shall continually agitate the boring fluid during boring operations.

B. Drilling Fluids: Drilling fluids shall be composed of clean water and an appropriate additive. Water shall be from a clean source with a pH of 6.0. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No hazardous additives may be used.

C. Delivery System: The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used boring fluid and boring fluid spilled during boring operations shall be contained and properly disposed of. A berm, minimum of 12 inch high, shall be maintained around boring equipment, boring fluid mixing system, entry and exit pits and boring fluid recycling system (if used) to prevent spills into the surrounded environment. Pumps and/or vacuum truck(s) of sufficient size shall be in place to convey excess boring fluid from containment areas to storage facilities.

D. Drilling Fluid Recovery System: The drilling fluid recycling system shall separate sand, dirt, and other solids from the drilling fluid to render the drilling fluid re-usable. Spoils separate from drilling fluid will be stockpiled for later use or disposal.

E. Control of Drilling Fluids: The CONTRACTOR shall control operational pressures, drilling mud weights, drilling speeds, and any other operational factors required to avoid hydro-fracture fluid losses to formations, and control drilling fluid spillage. This includes any spillages or returns at entry and exit locations or any intermediate point. All inadvertent returns or spills shall be promptly contained and cleaned up in accordance with OWNER procedures. The CONTRACTOR shall maintain on-site mobile spoil removal equipment during all drilling, pre-reaming, reaming and pullback operations and shall be capable of quickly removing spoils.

2.7 OTHER EQUIPMENT

A. Pipe Rollers, if required, shall be of sufficient size to fully support the weight of the pipe while being hydro tested during the pull-back operations. Sufficient number of rollers shall be used to prevent excess sagging of pipe.

B. Hydraulic or pneumatic pipe rammers may only be used if necessary and with OWNER approval.

C. Other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections shall not be used unless approved by the OWNER prior to commencement of the work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete the utility placement satisfactorily without undue stoppage and to maintain line and grade within the tolerances prescribed by the particular conditions of the project.

PART 3 - EXECUTION

3.1 DRILLING PROCEDURE

A. Bore Path Survey.

1. Entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within areas indicating on drawings. If CONTRACTOR is using a magnetic guidance system, drill path will be surveyed for any surface geo-magnetic variations or anomalies.

B. Guidance System.

1. CONTRACTOR shall provide and maintain instrumentation necessary to accurately locate the pilot hole (both horizontal and vertical displacements), measure pilot string torsional and axial and measure drilling fluid discharge rate and pressure. The OWNER shall have access to these metrics at all times during operation.

C. Pilot Hole.

1. The pilot hole shall be drilled along the approximate path shown on the plans and profile drawings or as directed by the OWNER in the field.

D. Pull Back.

1. After successfully reaming bore hole to the required diameter, CONTRACTOR will pull the conduit through the bore hole. In front of the pipe will be a swivel. Once pull-back operations have commenced, operations must continue without interruption until conduit is completely pulled into bore hole. During pull-back operations CONTRACTOR will not apply more than the maximum safe pipe pull (tensile) strength at any time.

2. Torsional stress shall be minimized by using a swivel to connect a pull section to the reaming assembly.

3. The pullback section of the pipeline shall be supported during pullback operations so that it moves freely and the pipe is not damaged.

4. External pressure shall be minimized during installation of the pullback section in the reamed hole. Damaged pipe resulting from external pressure shall be replaced at no cost to the OWNER.

5. Buoyancy modification shall be at the discretion of the CONTRACTOR and shall be approved by the OWNER. The CONTRACTOR shall be responsible for any damage to the pull section resulting from such modifications.

6. In the event the conduit becomes stuck, CONTRACTOR will cease pulling operations to allow any potential hydro-lock to subside and will commence pulling operations. If conduit remains stuck, CONTRACTOR will notify the OWNER and discuss options to proceed.

3.2 PIPE ASSEMBLY

A. Conduit shall be installed together in one length, if space permits. Pipe may be placed on pipe rollers before pulling into bore hole to minimize damage to the conduit.

B. Cuts or gouges that reduce the wall thickness by 10 percent or more is not acceptable and must be discarded.

3.3 TESTING

A. Proof all conduit before installation of cabling and detectable 1200-pound mule tape in any conduit that does not require the installation of innerduct or microduct.

1. Use a mandrel at least 80 percent of the conduit diameter, at least twice as long as the conduit diameter, and composed of rigid material.

2. Schedule proofing with the ENGINEER at least 5 working days in advance of performing the work.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.

1.2 RELATED SECTIONS

A. Not Applicable.

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For each electrical identification product indicated.
2. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.5 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.

2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING."

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

D. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical- resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

C. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3 mil thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

E. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

F. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

G. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

D. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

1. Overall Thickness: 5 mils.

2. Foil Core Thickness: 0.35 mil.

3. Weight: 28 lb/1000 sq. ft.

4. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

C. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.

2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.

3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.

2. 1/4-inch grommets in corners for mounting.

3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.

2. 1/4-inch grommets in corners for mounting.

3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR:

a. Working Voltage 208V: 36 inches.

b. Working Voltage 480V: 48 inches.

c. Working Voltage 4160V: 60 inches.

d. Working Voltage: 12,470V: 10 feet.

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.

2. Punched or drilled for mechanical fasteners.

3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Minimum letter height shall be 3/8 inch. Color-code labels based on the electrical system branch as indicated in the Execution section below.

B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.8 CABLE TIES

A. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout the Project.

F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

K. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

L. Circuit Identification Labels on Boxes: Install labels externally.

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.

2. Concealed Boxes: Plasticized card-stock tags.

3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.

2. Power.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

b. Colors for 208/120-V Circuits:

1) Phase A: Black.

2) Phase B: Red.

3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.

2) Phase B: Orange.

3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Power-Circuit Conductor Identification, more than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

D. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.

E. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes with the conductor designation.

F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.

3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

   a. Power transfer switches.

   b. Controls with external control power connections.

K. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

L. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.

M. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

   a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2 inch high letters on 1-1/2 inch high label; where two lines of text are required, use labels 2 inches high.

   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label stenciled legend 4 inches high.

   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

   d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

   e. Color Coding of Labels: Identify branch of electrical system by coloring coding the labels.

      1) Equipment Connected to Normal Power: White lettering on black background.

      2) Equipment Connected to Emergency (life-safety) Power: White lettering on red background.

3) Equipment Connected to Stand-by(optional) Power: Red lettering on white background.

4) Equipment Connected to UPS Power, "A" system: White lettering on orange background.

5) Equipment Connected to UPS Power, "B" system: White lettering on blue background.

6) Equipment Connected to UPS Power, non-redundant office system: Orange lettering on white background.

f. Identify source bus, voltage and location feeding the equipment, for example:

PANEL 3LBA
120/208V 3-PHASE 4-WIRE

FED FROM 3LDPB
ROOM #1003

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.

b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.

d. Switchgear.

e. Switchboards.

f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

g. Substations.

h. Emergency system boxes and enclosures.

i. Motor-control centers.

j. Enclosed switches.

k. Enclosed circuit breakers.

l. Enclosed controllers.

m. Variable-speed controllers.

n. Push-button stations.

o. Power transfer equipment.

p. Remote-controlled switches, dimmer modules, and control devices.

q. Battery-inverter units.

r. Battery racks.

s. Power-generating units.

t. Monitoring and control equipment.

END OF SECTION

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching controls.
4. Indoor occupancy sensors.
5. Outdoor motion sensors.
6. Lighting contactors.
7. Emergency shunt relays.

B. Related Requirements:

1. Section 26 27 26 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.
2. Section 01 60 01 “Buy America Requirements” for special product requirements.

1.2 RELATED SECTIONS

26 27 26 – Wiring Devices

26 05 19 – Low-Voltage Electrical Power Conductors and Cables

26 05 53 – Identification for Electrical Systems

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. 26 05 19 “Low-Voltage Electrical Power Conductors and Cables.”

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.

2. Shop Drawings: Show installation details for occupancy and light-level sensors.

    a. Interconnection diagrams showing field-installed wiring.

    b. Include diagrams for power, signal, and control wiring.

B. Information Submittals:

1. Field quality-control reports.

C. Closeout Submittals:

1. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Electromechanical-Dial Time Switches: Comply with UL 917.

1. Contact Configuration: DPDT.

2. Contact Rating: 30-A inductive or resistive, 240-V ac.

3. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.

4. Astronomic time dial.

5. Eight-Day Program: Uniquely programmable for each weekday and holidays.

6. Skip-a-day mode.

7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Contact Configuration: SPST.

3. Contact Rating: 20-A ballast load, 120-/240-V ac.

4. Programs: Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.

5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.

6. Astronomic Time: All channels.

7. Automatic daylight savings time changeover.

8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Description: Solid state, with DPST dry contacts rated to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.

3. Time Delay: Fifteen second minimum, to prevent false operation.

4. Surge Protection: Metal-oxide varistor.

5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.3 INDOOR PHOTOELECTRIC SWITCHES

A. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output:

a. On/Off Relay: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.

b. Analog Output: 0 - 10VDC, proportional to the amount of monitored light, to directly control a dimming device, or connect to a central daylighting control unit.

2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

3. Light-Level Monitoring Range: 10 to 1000 fc (108 to 10 800 lx), with an adjustment for turn-on and turn-off levels within that range.

4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.

5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

B. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output:

a. On/Off Relay: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.

b. Analog Output: 0 - 10VDC, proportional to the amount of monitored light, to directly control a fluorescent dimming ballast, or connect to a central daylighting control unit.

2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13- A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

3. Light-Level Monitoring Range: 10 to 1000 fc (108 to 10 800 lx), with an adjustment for turn-on and turn-off levels within that range.

4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.

5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.4 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).

3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.

4. Power Pack: Dry contacts rated for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.

6. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.

7. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.

8. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.

9. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.

10. Test Mode: User selectable, overriding programmed time delay to allow settings check.

11. Control Load Status: User selectable to confirm that load wiring is correct.

12. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.5 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:

a. When no daylight is present (target level).

b. When significant daylight is present.

2. System programming is done with two hand-held, remote-control tools.

a. Initial setup tool.

b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

B. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.

3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.

4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

2.6 INDOOR OCCUPANCY SENSORS

A. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate relay unit power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.

4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

5. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13- A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

6. Auxiliary Relay: For connection to the building automation system to monitor room occupancy.

7. Mounting:

   a. Sensor: Suitable for mounting in any position on a standard outlet box.

   b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.

   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

8. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.

9. Bypass Switch: Override the "on" function in case of sensor failure.

10. Automatic Light-Level Sensor (where indicated): Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

B. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using passive infrared (PIR) and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.7 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).

3. Switch Rating: Not less than 1000-VA LED at 277 V.

4. Standard Range:180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft (196 sq. m).

5. Sensing Technology: Dual technology - PIR and ultrasonic.

6. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."

7. Voltage: Match the circuit voltage; dual-technology type.

8. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

9. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

10. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.

11. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.8 OUTDOOR MOTION SENSORS

A. General Requirements for Sensors: Solid-state outdoor motion sensors.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Dual-technology (PIR and ultrasonic) type, weatherproof. Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm). Comply with UL 773A.

3. Switch Rating:

   a. Lighting-Fixture-Mounted Sensor: 1000-W incandescent, 500-VA fluorescent.

   b. Separately Mounted Sensor: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

4. Switch Type: SP, dual circuit or SP, field selectable automatic "on," or manual "on" automatic "off" with bypass switch to override the "on" function in case of sensor failure.

5. Voltage: Match the circuit voltage type.

6. Detector Coverage:

   a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).

   b. Long Range: 180-degree field of view and 110-foot (34-m) detection range.

7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.

10. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as "raintight" according to UL 773A.

2.9 HIGH-BAY OCCUPANCY SENSORS

A. General Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.

3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.

4. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).

5. Mounting: Threaded pipe.

6. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

7. Detector Technology: PIR.

8. Power and dimming control from the lighting fixture ballast that has been modified to include the dimming capacitor and MyzerPORT option.

B. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet (3.7 to 15.2 m).

C. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.10 EMERGENCY SHUNT RELAY

A. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120-277 V.

2.11 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "Low- Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

2.12 LIGHTING CONTACTORS

A. Description: Electrically operated and electrically held, combination-type lighting contactors with non-fused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).

2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

3. Enclosure: Comply with NEMA 250.

4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

B. Interface with DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.

1. Monitoring: On-off status.

2. Control: On-off operation.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."

1. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit OWNER's operations.

2. For daylighting controls, adjust set points and deadband controls to suit OWNER's operations.

3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train OWNER's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 26 09 26

PANELBOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrical distribution panelboards.

2. Connections between fixtures, equipment, and panelboards.

1.2 RELATED SECTIONS

A. Not Applicable.

1.3 REFERENCES

A. NEMA Standards:

1. 1 Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

2. 250 Enclosures for Electrical Equipment (1000 Volt Maximus).

B. NFPA Standards:

1. 70 National Electric Code.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer’s data including specifications, installation instructions and general recommendations, for each type of panelboard required.

B. Shop Drawings. Submit showing accurately scaled layouts of enclosures and required individual panelboard devices. Show circuit breakers, fusible switches, fuses, ground-fault circuit interrupters, and accessories.

1.5 QUALITY ASSURANCE

A. Construct panelboards to NEMA 1 and NEMA 250 Standards and provide UL labels.

B. Comply with NFPA 70 pertaining to installation of wiring and equipment in hazardous locations.

C. Make all grounding tight and secure throughout.

D. Ensure panelboards and components are designed and tested to withstand vibrations and dynamic loads in railway installations, meeting or exceeding IEC 60068-2-6 standard for vibration resistance and ANSI/ISA 60079-0 standard for durability.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 PANELBOARD – GENERAL

A. Provide panelboards of the same make and key alike with a master key arrangement.

B. Use dead front panelboards with one-piece cabinets constructed from code gage steel. Cabinets shall have knockouts and minimum gutter space of four (4) inches on all sides.

C. Provide branches with automatic circuit breakers, thermal-magnetic type, unless indicated otherwise. Multi-pole breakers shall automatically open all poles when an overload occurs in any pole. Branch circuit breakers used for switching duty shall be UL listed as SWD type. Ground-fault circuit interrupter protection as required by NFPA 70 shall be provided by ground-fault circuit interrupting breakers. Circuit breakers shall have positive trip indication as well as clear "off' and "on" indication.

D. Use factory assembled panelboards with amp rating units indicated. Provide spare units and blank spaces as indicated. Main circuit breaker or lugs only as indicated.

E. Affix large, permanent individual numbers to each breaker on panelboard face in a uniform position. Number starting at the top, with odd numbers used in sequence down left hand side and even numbers used in sequence down right hand side.

F. Use fronts manufactured with code gage steel, finished with rust inhibiting primer and baked enamel finish and manufacturer's standard color. Provide doors with flush tumbler type locks. Provide a circuit directory frame and card with a clear plastic covering inside the door.

G. Furnish locking clips for "off' position only, with "on" trip free travel and installed in all circuits so indicated.

H. Label panel with black phenolic or acceptable alternate engraved nameplate with 1/4-inch-high lettering on the interior of each panelboard; including panel name and voltage. Provide red nameplate on emergency system panels.

I. For outside locations use a NEMA 4R cabinet.

J. Ensure panelboards meet or exceed IP54 rating for protection against dust and water ingress, suitable for railway environments.

2.2 PANELBOARD - 480 VOLT

A. Voltage: 277/480 volts, three (3) phase, four (4) wire, S/N, equipped with automatic circuit breaker.

B. Circuit Breakers: Minimum interrupting capacity of 14,000 amps at 277 volts. Use breakers that are UL rated for use as switches.

C. Locking Clips: Five (5) minimum per panel.

2.3 PANELBOARD - 208 VOLT

A. Voltage: 120/208 volts, three (3) phase, four (4) wire, S/N, equipped with automatic circuit breakers.

B. Circuit Breakers: Minimum interrupting capacity of 10,000 amps at 120 volts.

2.4 PANELBOARD - SAFETY AND PROTECTION FEATURES

A. Provide panelboards with integrated Arc Flash protection systems to minimize the risk of injury to personnel and damage to equipment in the event of an arc flash incident.

B. Ensure panelboards are equipped with surge protection devices to protect against transient overvoltage, especially in areas prone to lightning strikes or power surges.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide mounting brackets, bus bar drillings and filler pieces for unused spaces.

B. Prepare and affix typewritten directory to inside cover of panelboard indicating loads controlled by each circuit.

C. Install per NFPA 70, NEMA, manufacturer's instructions and authorities having jurisdiction.

D. Coordinate with other trades to ensure proper cable routing and segregation, minimizing electromagnetic interference (EMI) and maintaining optimal performance of communication and control systems in railway installations.

END OF SECTION

SECTION 26 13 13

CIRCUIT BREAKER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Installation of motor circuit breaker and circuit disconnects.

1.2 RELATED SECTIONS

A. Not Applicable.

1.3 REFERENCES

A. NEMA Standards:

1. 250 Enclosures for Electrical Equipment (1000 Volts Maximus).

2. KS Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).

B. NFPA Standards:

1. 70 National Electric Code.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data including specifications, installation and general recommendations, for each type of motor and circuit disconnect switch required.

B. Shop Drawings: Submit dimensioned drawings of electrical motor and circuit disconnect switches which have a rating of 100 amperes and larger.

1.5 QUALITY ASSURANCE

A. Conform to:

1. NFPA 70.

2. Local and state codes and to authority having jurisdiction.

B. Provide switches that are UL listed and labeled. Comply with NEMA KS 1 and NFPA 70.

C. Ensure circuit breakers and components are designed and tested to withstand vibrations and dynamic loads in railway installations, meeting or exceeding IEC 60068-2-6 standard for vibration resistance and ANSI/ISA 60079-0 standard for durability.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 GENERAL

A. Motor and circuit disconnects shall have a UL label.

B. Single Phase Disconnect Switches: Two (2) pole switch.

C. Ensure circuit breakers meet or exceed IP54 rating for protection against dust and water ingress, suitable for railway environments.

2.2 GENERAL DUTY SWITCHES

A. Sheet steel enclosed switches, fusible or non-fusible as indicated of types, sizes and electrical characteristics indicated.

B. Rated 240 volts, 60 hertz.

C. Spring assisted, quick-make, quick-break mechanisms.

D. Provide single phase or three phase with solid neutral as required by application.

E. Equip with padlock handle in OFF position.

F. Provide NEMA enclosures as required by application.

G. Provide fusible switches with Class R rejection fuse clip kits.

2.3 MAINTENANCE STOCK, FUSES

A. Provide as required classes, types, and ratings for electrical requirements for service indicated.

B. Furnish additional fuses amounting to 1 unit for every 10 installed units, but not less than five (5) units of each, for both power and circuit fuses.

2.4 CIRCUIT BREAKER - SAFETY AND PROTECTION FEATURES

A. Provide circuit breakers with integrated Arc Flash protection systems to minimize the risk of injury to personnel and damage to equipment in the event of an arc flash incident.

B. Ensure circuit breakers are equipped with surge protection devices to protect against transient overvoltage, especially in areas prone to lightning strikes or power surges.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motor and circuit disconnect within sight of controller position.

B. Coordinate motor and circuit disconnect installation work with electrical race way and cable work.

C. Coordinate with other trades to ensure proper cable routing and segregation, minimizing electromagnetic interference (EMI) and maintaining optimal performance of communication and control systems in railway installations.

END OF SECTION

SECTION 26 29 13

MOTOR CONTROLLER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Installation of motor starters for electric motor driven equipment.
2. Types of motor starters include:
    a. AC fraction horsepower manual starters.
    b. AC line voltage manual starters.
    c. AC non-reversing magnetic starters.
    d. AC combination non-reversing magnetic starters.

1.2 RELATED SECTIONS

A. Not Applicable.

1.3 REFERENCES

A. NEMA Standards:

1. 250 Enclosures for Electrical Equipment (1000 Volts Maximum).

B. NFPA Standards:

1. 70 National Electric Code.

C. UL Standards:

1. 508 Electrical Industrial Control Equipment.

1.4 SUBMITTALS

A. Product Data: Manufacturer's data on motor starters.

B. Shop Drawings: Submit dimensioned drawings of motor starters showing accurately scaled equipment layouts.

C. Motor Voltage/Current Report: After installation is complete including water and air balancing, measure voltage (L-L and L-N) and full load current of each phase of each motor. Submit report showing field readings of voltage, amperage, and thermal heater size installed for each motor.

1.5 QUALITY ASSURANCE

A. Comply with NEMA, UL 508, and NFPA 70 standards as applicable to wiring methods, construction and installation of motor starters.

B. Provide units which have been UL-listed and labeled.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 MOTOR STARTER

A. Provide motor starters and ancillary components of types, sizes, ratings and electrical characteristics indicated.

B. Materials, design and construction is manufacturer's option unless indicated.

C. Thermal Overload Units: Sized to actual running full load current, not to motor plate current. Size heaters for mechanical equipment after air and water balancing have been completed.

2.2 AC FRACTIONAL HP MANUAL STARTER

A. Single-phase, 1 and 2 pole, 300 volt AC maximum unless indicated.

B. Equip with 1 piece thermal overload relay with field adjustment capability of plus or minus 10 percent of nominal overload heater rating; for protection of AC motors of 1 HP and less. (For manually controlled motors in excess of 1 HP, refer to motor line voltage manual starter).

C. Motor Protection Switches: Quick-make, quick-break trip free toggle mechanism, green pilot lights, with lock-off toggle operated handle. Mount surface units in NEMA 1 enclosures, unless indicated. Provide NEMA 3R enclosure in exterior or damp location. Provide flush mounted units with coverplate to match wiring device coverplates.

2.3 AC LINE VOLTAGE MANUAL STARTER

A. 2 or 3 pole, 600 volt AC maximum unless indicated.

B. Equip with pushbutton operator, low voltage protection feature and green pilot light.

C. Motor Protection Switches: Trip free mechanism such that contacts will open under load and remain open until thermal element has cooled, and unit is reset. Mount surface units in NEMA 1 enclosure unless indicated. In exterior or damp location provide NEMA 3R enclosure. Provide flush mounted units with coverplate to match wiring device coverplates.

2.4 AC NON-REVERSING MAGNETIC STARTER

A. 2 or 3 pole, 600 volts maximum, with thermal overload position in all phases and inherent under voltage release.

B. Molded case automatic air circuit breakers.

C. Contactor with three (3) overload relays.

D. 120 volt holding coil.

E. Pilot light in cover, green resistor type.

F. Reset button, and Hand-Off-Automatic switch in cover, field convertible to Off/Auto or Start/Stop push button.

G. Two (2) sets of normally open, auxiliary contacts in addition to standard auxiliary holding contact supplied with each contactor.

H. 120 volt control transformer of sufficient capacity to handle operating coil and associated controls.

I. Surface mounted starters in NEMA Type 1 enclosure unless indicated. In exterior or damp locations provide NEMA 3R enclosure.

2.5 AC COMBINATION NON-REVERSING MAGNETIC STARTER

A. Molded case automatic air circuit breakers with rotary operating handle and lock off facility.

B. Restrict opening of switch enclosure by the use of a defeater screw unless switch is in the "off' position.

C. Contacts with three (3) overload delays.

D. 120 volt holding coils.

E. Pilot light in cover, green resistor type.

F. Reset button, and Hand—Off-Automatic switch in cover, field convertible to Off-Auto or Start-Stop push button.

G. Two (2) sets of normally open, auxiliary contacts in addition to standard auxiliary holding contact supplied with each contactor.

H. 120 volt control transformer of sufficient capacity to handle operating coil and associated controls.

2.6 MAINTENANCE STOCK, FUSES

A. Provide as required of classes, types, and ratings for electrical requirements for service indicated.

B. Furnish additional fuses amounting to 1 unit for every 10 installed units, but not less than five (5) units of each, for both power and circuit fuses.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install NEMA size motor protection switches. For units not using NEMA rating, use equivalent NEMA size.

B. In finished areas mount motor protection switches flush and install suitable cover-plates.

C. Install heaters correlated with full load current of motor provided.

D. Install fuses in fusible circuit breaker, if any. Mount chart inside each starter indicating heater type, size, and ampere rating.

END OF SECTION

SECTION 26 56 00

EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior luminaires.

2. Poles and accessories.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.

1.2 RELATED SECTIONS

03 30 00 **–** Cast-in-Place Concrete

26 05 26 **–** Grounding and Bonding for Electrical Systems

26 05 33 **–** Raceways and Boxes for Electrical Systems

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

a. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

b. Details of attaching luminaires and accessories.

c. Details of installation and construction.

d. Luminaire materials.

e. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps and accessories.

1) Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

f. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.

g. Materials, dimensions, and finishes of poles.

h. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

i. Anchor bolts for poles.

j. Manufactured pole foundations.

2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

b. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

c. Design calculations, certified by a qualified professional engineer, indicating strength of foundations soil conditions on which they are based.

d. Wiring Diagrams: For power, signal, and control wiring.

B. Informational Submittals:

1. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS- 4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

2. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

3. Field quality-control reports.

4. Warranty: Sample of special warranty.

C. Closeout Submittals:

1. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

D. Maintenance Material Submittals:

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

    a. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 20 of each type and rating installed. Furnish at least one of each type.

    b. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. LER: Luminaire efficacy rating.

D. Luminaire: Complete lighting fixture.

E. Pole: Luminaire support structure, including tower used for large area illumination.

F. Standard: Same definition as "Pole" above.

1.8 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.

D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1. Basic wind speed for calculating wind load for poles 50 feet high or less is 100 mph with a 1.3 gust factor, and minimum design life of 30 years.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.

3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC- SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected by ENGINEER from manufacturer's full range.

N. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

2.2 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.

2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.3 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: As indicated.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

3. Hinged pole base assembly where indicated.

B. Steel Mast Arms: configurations and types indicated, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.

2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.

3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

F. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

G. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC- SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected by ENGINEER from manufacturer's full range.

2.4 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.

2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.

3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.

2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.

3. Install base covers unless otherwise indicated.

4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 2 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast- in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010 inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.

2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source. Conduct these observations after dark.

1. Verify operation of photoelectric controls.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION

SECTION 26 56 19

ROADWAY LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Implementation of environmental, health, and safety considerations during installation.
2. Assurance and control for quality during installation and testing.
3. Roadway lighting system materials and installation procedures.
4. Testing, painting, restoration, and salvage tasks post-installation.

1.2 RELATED SECTIONS

03 30 00 **–** Cast in Place Concrete

03 61 00 **–** Cementitious Grouting

26 05 13 **–** Conductors and Cables

26 05 33 **–** Raceways and Boxes for Electrical Systems

26 05 34 **–** Electrical Boxes and Fittings

31 23 16 **–** Excavation

32 92 00 **–** Turf and Grass

32 93 13 **–** Ground Cover

33 05 20 **–** Backfilling Trenches

33 05 25 **–** Pavement Restoration

1.3 REFERENCES

A. ASTM Standards:

1. B3 Soft or Annealed Copper Wire.
2. B8 Concentric—Lay-Stranded Copper Conductors, Hard, Medium—Hard, or Soft.
3. D2301 Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.

B. NEMA Standards:

1. 250 Enclosures for Electrical Equipment (1000 Volts Maximus).

C. NFPA Standards:

1. 70 National Electric Code.

D. SSPC Standards:

1. 25 BCS Zinc Oxide Alkyld, Linseed Oil Primer for.

1.4 SUBMITTALS

A. Manufacturer Certificates: Certify that products of this section are manufactured to comply with the required standards and good practices.

B. Electrical load calculation.

C. Shop Drawings and Product Data: Complete, bound, indexed, large enough for all items included. When requested, supplement the following list by such other data as may be required, including detailed scale drawings and wiring diagrams of any special equipment and of any proposed deviation from the Contract Documents:

1. Performance data for luminaires, including lighting contours on the roadway surface and average maintained level of light in foot-candles.

2. Shop Drawings for luminaires showing pertinent physical characteristics, type of light source, and wattage.

3. Shop Drawings of ornamental poles.

4. Luminaire supports.

5. Pole bases.

6. Wiring schematic.

7. Fixture mounting height.

8. Drawing showing location of poles and underground power conduit.

D. Warranties and instruction sheets.

1. Include details on warranty duration, coverage, and claim process. Provide comprehensive operation and maintenance instructions for all installed systems.

E. Testing results of this section article 3.9.

1. Testing protocols used and complete reports detailing the results and any relevant actions taken.

1.5 QUALITY ASSURANCE

A. Not Applicable.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 MAINTAINING EXISTING AND TEMPORARY ELECTRICAL SYSTEMS

A. Notify ENGINEER before performing any work on existing systems.

B. Allow 20 feet minimum overhead clearance across thoroughfares and 12 feet minimum clearance above sidewalk areas. Do not run temporary conductor on top of the ground or across any sidewalk area unless protected in an electrical raceway and barricaded.

C. Maintain existing electrical systems or approved temporary replacements, in effective operation for the benefit of the traveling public during the progress of the Work, except when shutdown is permitted to allow for alteration or removal of the systems. Do not interfere with the regular lighting schedule.

PART 2 - PRODUCTS

2.1 EXISTING MATERIALS

A. Where existing systems are to be modified, incorporate existing material in revised system, salvage, or abandon.

2.2 CONDUCTORS

A. Materials:

1. Solid or stranded copper of size indicated conforming to ASTM B3 and ASTM B8.

2. Insulation; RHH-RHW-USE grade cross link polyethylene compound.

3. Color and coding of l20/240 volt, Section 26 05 13 “Conductors and Cables.”

B. Splicing:

1. Compatible with cable insulation and water seal for underground use. Comply with UL code.

2. Compatible with cable insulation and water seal for underground use. Splices should be insulated to the same level as the cable itself. Comply with UL code.

C. Conduit:

1. Section 26 05 33 “Raceways and Boxes for Electrical Systems.”

2.3 POLES AND LUMINAIRE SUPPORTS

A. AASHTO standard specification for structural supports for highway signs, luminaires, and traffic signals.

B. Material: Specified material for poles and luminaire supports on plans.

C. Height, type, configuration, and base detail requirement on plans.

2.4 JUNCTION BOXES

A. Buried type; Section 26 05 34 “Electrical Boxes and Fittings” and as follows:

1. Precast reinforced concrete in sidewalk and paved surfaces.

2. Plastic in landscaped surfaces.

B. Cover Stencil: "Street Lighting". Where box contains street lighting voltage greater than 600 volts, stencil "High Voltage."

2.5 INSULATING TAPE

A. Type 1 vinyl chloride, ASTM D2301.

2.6 LUMINAIRE

A. Luminaire Assembly: Standard Highway Luminaire (Cobra Head) shoe box design:

1. Die-cast aluminum housing with high temperature wiring.

2. Reflectors, sockets, mounting cradles, and clamps properly fitted to the housing.

3. Luminaire weight and projected area within design loading limits.

4. Replaceable air filter and IES distribution type as indicated.

B. Mounting adjustment:

1. Ten degrees above horizontal for the reflector and refractor.

2. Five degrees adjustment from vertical on the bracket arm.

C. Lamps: Metal halide, 250 or 400 watts as indicated:

1. Clear uncoated, pulse start.

2. Apparent color temperature of 3800 K.

3. Rated-life of not less than 20,000 hours (400 Watt) or 10,000 hours (250 Watt) when used on a 10 hour per start duty cycle.

D. Ballast: Replaceable prewired with minimum primary power factor of 90 percent with normal secondary load with sufficient open circuit voltage to start lamps at minus 20 deg F Ballast shall provide regulation with five (5) percent variation in lamp watts with a 10 percent variation in primary voltage.

E. Bonding and Grounding: Copper wire strap No. 6 AWG minimum.

1. Bonding and grounding system should ensure the safety of maintenance personnel and protect the equipment from potential electrical faults.

2.7 CONTROL EQUIPMENT

A. General: Failure of any electrical component will energize the lighting circuit.

B. Photo-electric Control: At least one (1) and five (5) foot candles sensitivity. Incorporate a fail-safe mechanism to ensure lights remain on in case of photo-electric control failure.

C. Control Relay Contacts Rating: Switch on at 3,000 watts minimum.

D. Remote Control Relays: Normally open.

E. Relays: Either mechanical armature type or mercury tube type, single or double pole, or as indicated:

1. Mechanical armature type: An operating coil (120 volts), a laminated core, a laminated armature, terminals and silver alloy contacts.

2. Mercury tube type: An operating coil, hermetically sealed mercury tubes and terminals. Contacts shall be made either mercury to mercury or between mercury and alloy resistant to arcing and mercury amalgamation.

F. Enclosure: NEMA 250 Type 4 with dead front panel, keyed padlock.

G. Paint: Waterproof.

2.8 POLYSULFIDE BASE, SINGLE COMPONENT SEALANT

A. Chemical curing; capable of being continuously immersed in water, withstand movement up to 20 percent of joint width, and satisfactorily applied throughout a temperature range to 40 to 80 deg F, Shore A hardness of 15 minimum and 50 maximum; nonstaining and non- bleeding; color as selected by ENGINEER.

2.9 CONCRETE AND GROUT

A. Concrete: Class 3000 minimum cast-in-place, Section 03 30 00 “Cast in Place Concrete.”

B. Grout: Cement, Section 03 61 00 “Cementitious Grouting.”

PART 3 - EXECUTION

3.1 PREPARATION

A. Pre-installation meeting approximately two weeks before scheduled commencement of roadway lighting systems. Require attendance of parties directly affecting work of this section, including CONTRACTOR, ENGINEER, and installer. Review materials, installation procedures, and coordination with other work.

B. Locate and preserve utilities, Section 31 23 16 “Excavation.”

C. Excavate; Section 31 23 16 “Excavation” and backfill; Section 33 05 20 “Backfilling Trenches.”

D. Do not disturb roadway surface, sidewalk, curb, gutter, or other obstructions without approval.

E. Do not block or restrict pedestrian traffic, vehicle traffic, drainage or utilities.

F. Barricade all Excavations in traveled ways.

G. Compact excavated Trench material; Section 33 05 20 “Backfilling Trenches” to the requirements of the adjacent areas.

H. After backfilling Excavations, maintain smooth and well-drained surfaces until permanent repairs are affected.

I. Legally dispose of all excess or waste material.

3.2 POLE FOUNDATION

A. Construct foundation per details indicated in the plans.

B. Locations:

1. 18 inches clear from pull box.

2. Not in pedestrian access way.

3. Unless specified otherwise:

a. 5 feet from new tree.

b. 10 feet from existing tree, driveway, or hydrant.

c. Center of park strip or 24 inches clear from top back of curb on wide park strips.

3.3 CONDUIT INSTALLATION

A. In structural applications, use rigid steel conduit in areas subject to vehicular load, on the surface of structures, inside of structures and foundations, between structures, and the adjacent pull boxes located next to structures.

B. In buried utility applications, place conduit as follows.

Location	Depth of Burial (inches)
In front of curb faces	36 to 60
Back of the back of curb	24 to 36
Railroad tracks	36 to 60
Primary power cables	40 minimum

C. Use sizes of conduit indicated or use larger sizes for any run at no additional cost to OWNER. No expanding or reducing fittings will be permitted.

D. Make field cuts square and true so that the ends will come together for full circumference. Paint threads on all rigid steel conduit with rust preventive paint before couplings are made. Repair damaged coating on galvanized steel conduit.

E. Cap all conduit ends with standard pipe caps until wiring is installed. When caps are removed from metallic conduit, provide threaded ends and approved conduit bushings.

F. Clean all existing underground conduit to be incorporated into new system with a mandrel and blow out with compressed air. Where existing rigid steel conduit systems are to be modified or extended, install rigid steel conduit.

G. Make changes in direction by bending the conduit to a radius which will meet code or, preferable, by the use of standard bends or elbows.

H. Install a No. 12 AWG pull wire or equivalent strength cord in all conduits which are to receive future conductors. Leave at least two (2) feet of pull wire extending beyond each end of the conduit run and secure.

I. Center conduit ends within the bolt circle of traffic signal poles or pedestals.

J. Pack conduit ends with sealant after conductors are installed.

K. Cap all conduit terminated without a pull box and identify its location by monumenting.

L. Conduit Fill: Comply with applicable provisions of NFPA 70 for conduit fill. In no case should the maximum fill percentage be exceeded.

3.4 CONDUCTOR INSTALLATION

A. Install wiring per the appropriate articles of NFPA 70. Neatly arrange wiring within cabinets, junction boxes, etc.

B. Splice only at junction boxes, transformer leads, in pole bases, or at control equipment. Splice conductors as per manufacturer's recommendations and codes. Provide a fused connector between the line and the ballast, accessible at the hand holes located in the poles.

C. Provide conduit to separate low-voltage conductors from high-voltage conductors in the same raceway (i.e. poles).

D. Splice insulation shall consist of layers of vinyl chloride electrical insulating tape applied to a thickness equal to and well lapped over the original insulation to provide uninterrupted underwater operation.

E. Leave two (2) feet of slack at each pole. Leave 18 inches of slack above top of pull box grade.

F. Mark termination of each conductor. Where circuit and phase are clearly indicated by conductor insulation, bands need not be used, otherwise use bands.

G. Pulling Conductors: Do not pull conductors into place until satisfactory tests have been conducted. Use pulling means, including fish tapes, cable pullers, and pull strings that will not damage conductors and their insulation.

3.5 GROUNDING INSTALLATION

A. Effectively ground metallic cable sheaths, metal conduit, nonmetallic conduit grounding wire, ballast and transformer cases, service equipment, anchor bolts, metal poles, and pedestals, and make mechanically and electrically secure to form a continuous system. Use a copper wire strap for bonding and grounding jumpers of the same cross-sectional area as No. 6 AWG for all lighting systems.

B. Ground one side of the secondary circuit of series-multiple and step-down transformers. Ground metal conduit, service equipment, and neutral conductor at service point as required by NEC and electricity company with grounding conductor No. 6 AWG or larger.

C. In all nonmetallic (PVC) type conduit, provide a No. 8 AWG bare copper wire continuously and ground at each junction box.

D. At each multiple service point, unless otherwise indicated, furnish a ground electrode. Use copper coated ground electrodes of steel or iron in one piece lengths at least 3/4 inch in diameter. Do not use electrodes of nonferrous materials less than 1/2 inch in diameter.

E. Bond metal poles by means of a No. 8 AWG bonding wire attached from a grounding bushing to a foundation bolt or to a 3/16 inch or larger brass or bronze bolt installed in the lower portion of the pole.

F. On wood poles, ground all equipment mounted less than eight (8) feet above the ground surface.

G. Ground metallic conduit or bonding conductor system at intervals less than 500 feet to one of the following:

1. 1 inch galvanized pipe driven eight (8) feet deep.

2. 1/2 inch copper rod driven eight (8) feet deep.

3. Metal water main with the approval of the water company. Clean water main thoroughly before connection.

H. Use galvanized grounding bushings and bonding jumpers for bonding metallic conduit in a concrete pull box. Use lock nuts for bonding metallic conduit in steel pull boxes, one inside and one outside of the box.

I. Pull Boxes: Install 3/4 inch x 10 feet copper clad ground rods at each pull box, six (6) inches above bottom. Ground all metal parts, neutral and ground wire with #6 B.C. Use exothermic weld or hammerlock connection.

3.6 JUNCTION AND PULL BOX INSTALLATION

A. Install at locations indicated, and at additional points when conduit runs are more than 200 feet. Without additional cost to OWNER and at CONTRACTOR's convenience add such additional boxes as may be desired to facilitate the work.

B. Rest bottom of pull box firmly on 12 inches thick bed of 1 inch crushed rock extending a minimum of six (6) inches beyond the outside edge of box.

C. Establish grade of top of boxes as for foundations.

D. Place long side of box parallel to curb unless indicated.

E. Use box extensions if ballasts or transformers are installed in box.

F. Do not install boxes in Driveway aprons.

3.7 LUMINAIRE AND BALLAST INSTALLATION

A. Immediately before installation, clean all light control surfaces, refractors, and reflectors to provide the maximum lumen output possible. Clean per luminaire manufacturer's recommendations.

B. Mount at height indicated.

C. Adjust luminaires individually to give the optimum light distribution.

3.8 PAINTING

A. Exterior Painting, Section 09 91 13.

B. Recoat all painted equipment when relocated.

C. Use two (2) coats of paint on relocated and new work.

3.9 FIELD QUALITY CONTROL

A. Conduct and record date and time of following tests:

1. Continuity of each circuit.

2. Grounds in each circuit.

3. Megger test at 500 volts DC on each completed lighting circuit. The insulation resistance to ground shall be 10 megohms minimum.

4. Voltage and current on each circuit.

B. Functional Test:

1. Perform a functional test. Demonstrate each and every part of the system functions as specified or intended.

2. A functional test for each new or modified electrical system will consist of not less than five (5) days of continuous, satisfactory operation. If unsatisfactory performance of the system develops, correct the condition and repeat the test until the five (5) days continuous satisfactory operation is obtained.

3. Do not start functional tests or turn-ons on Friday, or on the day preceding a legal holiday.

4. Shutdowns caused by factors beyond CONTRACTOR's control will not constitute discontinuity of the functional test.

C. Replace or correct any material revealed by these tests to be faulty.

D. Provide equipment, personnel, cable connections, and electrical energy for testing. Certify that each circuit has been completely tested and testing procedures are satisfied.

3.10 SALVAGE

A. Terminate all conduit abandoned in place at least five (5) inches below finished grade.

B. Exercise care in removing equipment to be reused or salvaged so that it will remain in the condition existing before its removal.

3.11 RESTORATION

A. Replace damaged equipment, concrete work or other fixtures or features disturbed or damaged by the installation.

B. Restore paved surfaces, Section 33 05 25 “Pavement Restoration.”

C. Finish landscaped surfaces to match existing with grass, Section 32 92 00 “Turf and Grass” or with other ground cover, Section 32 93 13 “Ground Cover.”

END OF SECTION

Division 27 – Communications

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.2 RELATED SECTIONS

A. 01 78 23 – Operation and Maintenance Data.

B. Division 26 Specifications pertaining to sleeves, pathways, grounding and bonding.

C. Section 26 05 49 – Seismic Controls for Electrical Systems.

D. Division 27 Specifications.

E. Division 28 Specifications.

1.3 REFERENCES

A. UL Standards:

1. UL 486A-486B: Standard for Wire Connectors.
2. UL 969: Standard for Marking and Labeling Systems.

B. ASTM Standards:

1. ASTM B 3: Standard Specification for Soft or Annealed Copper Wire
2. ASTM B 8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
3. ASTM B 33: Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes

C. TIA/EIA Standards:

1. TIA/EIA-606-A: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

2. TIA-607: Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises

D. NECA Standards:

1. NECA 1: Standard for Good Workmanship in Electrical Construction

E. IPC Standards:

1. J-STD-607-A: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

F. NFPA 70: National Electrical Code (NEC).

G. IEEE 1100: Recommended Practice for Powering and Grounding Electronic Equipment.

H. ANSI-J-STD-607-A: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

I. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2. BICSI Telecommunications Distribution Methods Manual.

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.

2. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work. Installation, terminating, and splicing procedures.

3. Installation, terminating, and splicing procedures.

B. Informational Submittals:

1. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

a. Ground and roof rings.

b. BCT, TMGB, TGBs, and routing of their bonding conductors.

2. Qualification Data: For Installer, installation supervisor, and field inspector.

3. Qualification Data: For testing agency and testing agency's field supervisor.

4. Field quality-control reports.

C. Closeout Submittals:

1. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

a. Ground rods.

b. Ground and roof rings.

c. TMGB, TGBs, and routing of their boding conductors (TBB).

2. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

a. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1) Result of the ground-resistance test, measured at the point of BCT connection.

2) Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Installer 2, who shall be present at all times when Work of this Section is performed at Project site.

2. Field Inspector: Currently registered by BICSI as a registered communications distribution designer to perform the on-site inspection.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Grounding: Comply with ANSI/TIA/EIA-J-STD-607-A and BICSI Telecommunications Distribution Methods manual Recommendation Practices.

D. Labeling: Comply with ANSI/TIA/EIA-606-A.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TBB: Telecommunications Bonding Backbone.

D. TGB: Telecommunications grounding busbar.

E. TMGB: Telecommunications main grounding busbar.

F. NEC: National Electrical Code, NFPA 70.

G. NRTL: Nationally Recognized Testing Laboratory.

H. BICSI: Building Industry Consulting Service International.

1.8 WARRANTY

A. Warranty: Manufacturer's standard warranty terms for all products supplied under this section shall be provided. The warranty shall commence on the date of acceptance and shall cover defects in materials and workmanship.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

A. Comply with ANSI/TIA/EIA-J-STD-607-A Commercial Building Grounding and Bonding Requirements.

2.2 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Harger Lightning and Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.
4. Or Approved Equal by the OWNER.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be UL-listed, Type THHN wire, sized per code and BICSI standard.

2. Cable Tray Equipment Grounding Wire: UL-listed, Type THHN wire, sized per code and BICSI standard.

D. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG [26 kcmils (13.3 sq. mm)] and not longer than 12 inches (300 mm). If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

2. Equipment Grounding: The grounding jumper should be used with an equipment grounding conductor of a size based on NEC Table 250.122, but in no case smaller than 12 AWG.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor, and 1/4 inch (6.3 mm) in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

F. The size of all bonding conductors shall follow the recommended sizes shown on the drawings.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Burndy; Part of Hubbell Electrical Systems.

2. Chatsworth Products, Inc.

3. Harger Lightning and Grounding.

4. Panduit Corp.

5. Tyco Electronics Corp.

6. Or Approved Equal by the OWNER.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

E. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4- mm) centers for a two-bolt connection to the busbar.

F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

G. Markings: Connectors shall be marked with the die index or color code to ensure the correct installation tools are used.

2.4 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Chatsworth Products, Inc.

2. Harger Lightning and Grounding.

3. Panduit Corp.

4. Or Approved Equal by the OWNER.

B. Comply with ANSI-J-STD-607A.

C. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, [1/4 by 4 inches (6.3 by 100 mm)] in cross section, length as required to allow for the quantity of connections indicated by the Drawings plus 25% spare capacity. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.

2. Mounting Hardware: Stand-off brackets that provide a [4-inch (100-mm)] clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. TGB: Predrilled rectangular bars of hard-drawn solid copper, [1/4 by 2 inches (6.3 by 50 mm)] in cross section, length as required to allow for the quantity of connection indicated on the Drawings plus 25% spare capacity. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.

2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch (50-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

E. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.

2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584- mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

3. Rack-Mounted Vertical Busbar: 72 or 36 inches (1827 or 914 mm) long, with stainless-steel or copper-plated hardware for attachment to the rack.

4. Hole patterns on the Busbars shall accommodate two-hole lugs per the recommendation of BICSI and J-STD-607-A.

5. Stand-off Insulators: Insulating material for stand-off insulators should be flame retardant and should not emit toxic fumes in case of a fire.

2.5 Ground Rods

A. Manufacturers: Subject to compliance with the requirements, available manufacturers offering products that may be incorporated into Work, include but are not limited to the following:

1. Brothers International Corporation.

2. Hellerman Tyton.

3. Or Approved Equal by the OWNER.

B. Ground Rods: One section copper-clad steel; 5/8” diameter by 96 inches long.

C. Ground Rod Connections: Exothermic weld process. Caldweld Series “GRC”.

2.6 Bonding Materials

A. Copper bonding jumpers, lugs, clamps, and connectors.

B. UL listed, suitable for the intended use and environment.

C. Exothermic welding materials or compression connectors as specified.

2.7 LABELING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brother International Corporation.

2. HellermannTyton.

3. Panduit Corp.

B. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

D. Durability: Labels should be permanent and resistant to environmental effects including moisture, dust, heat, UV light, and chemicals typically found in the installation environment.

E. The bonding conductors for telecommunications, TBB conductor, and each grounding equalizer shall be green or marked with a distinctive green color.

F. All cabling used to bond grounds are to be tagged with labels with the point of origin i.e. going to/coming from, with printed labels.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

E. Verify all components of the grounding electrode system for compatibility with each other.

3.2 INSTALLATION

A. All installation of the Telecommunications Ground Systems shall be performed by a BICSI certified Installer. This includes but is not limited to:

1. All busbars

2. All bonding conductors

3. Bonding to all non-active (non-current carrying) metal support structures, rack, runway, etc. within each Telecommunication Room or Space. Coordinate this bonding with the supplier and installer of rack, runway, etc.

B. Bonding shall include the AC utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

C. Comply with NECA 1.

D. Comply with J-STD-607-A.

E. All bonding components should be robust and resistant to corrosion, ensuring long-term integrity of the system.

F. All connections must be tight and secure to ensure efficient electrical continuity.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 10 AWG and smaller and stranded conductors for No. 8 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel frame buildings shall not be smaller than No. 3/0 AWG.

2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 3/0 AWG.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Connections to Structural Steel: Welded connectors.

C. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm.).

D. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.

2. Install without splices.

3. Support at not more than 36-inch (900-mm) intervals.

4. Install grounding and bonding conductors in PVC conduit sized in accordance with the NEC until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing and bond both ends of the conduit to a TGB.

E. All conductor terminations should be inspected for tightness and corrosion resistance.

F. All grounding and bonding conductors shall be installed in a manner that avoids any mechanical damage.

G. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMBG and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

B. Grounding Electrode System should be visually verified for proper installation and any signs of damage.

3.5 GROUNDING BUSBARS

A. Refer to drawings for busbar locations. Install busbars horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 12 inches (300 mm) above finished floor unless otherwise indicated.

B. All grounding busbars should be marked with their respective function and identification.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

   1. Use crimping tool and the die specific to the connector.

   2. Pretwist the conductor.

   3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot (1 sq. mm/linear meter) of conductor length, up to a maximum size of No. 3/0 AWG [168 kcmils (85 sq. mm)] unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame, provided that its bonding effectiveness has been verified via two-point bonding testing. This connection would be an acceptable alternative to routing of a Bonding Conductor for Telecommunications (BCT) to the main electrical panel board.

H. A bonding conductor can be routed between TMGB and the nearest effectively grounded AC electrical branch circuit panel board, provided a low ground impedance of the panel board has been verified with a ground impedance tester. This connection would be an acceptable alternative to routing of a BCT to the main electrical panel board.

I. All connections should be verified for proper torque as per the manufacturer's specifications.

J. All connections must be visibly inspected and tested for a secure mechanical and electrical connection.

K. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

L. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

M. Electronic System Equipment: Bond equipment chassis of other electronic system equipment including fire alarm, intrusion detection, access control, and educational school intercom and program systems to the TGB or TMGB located in their respective communication rooms.

3.7 TELECOMMUNICATIONS RACEWAY AND SUPPORT SYSTEM GROUNDING

A. Bond and ground raceway, cable rack or tray and conduit together and permanently ground to the equipment grounding busbar. Connection to conduit may be with grounding bushing or ground clamp.

B. Connect ladder-type cable tray to grounding electrode system. Telecommunications cable tray that is located in the same room as the TMGB shall be connected to the TMGB.

C. Bond and ground raceway at low voltage motor control centers or other low voltage control equipment, except conduit which is effectively grounded to sheet metal enclosure by bonding bushing or hubs need not be otherwise bonded.

D. Where a grounding conductor is run in or on a cable tray, bond grounding conductors to each section of cable tray with a cable tray ground clamp.

E. Where only grounding conductor is installed in a metal conduit, bond both ends of conduit to grounding conductors.

F. Provide flexible “jumpers” around raceway expansion joints and across cable tray joints parted to allow for expansion and hinged cable tray connections. Provide copper bonding straps for steel conduit.

3.8 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.

2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.

3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!" Refer to ANSI/TIA/EIA 606A for additional labeling requirements.

B. All labels must be legible, permanent, and resistant to environmental effects including moisture, heat, and UV light.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

   a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

   a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable AC current level is 1 A.

D. Additional testing should include verification of grounding system continuity and resistance measurements at multiple points in the system to ensure compliance with the specified resistance values.

E. All test and inspection reports should include details of the testing methodology, test results, observations, and any corrective actions taken.

F. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify ENGINEER promptly and include recommendations to reduce ground resistance.

G. If grounding system is found to be defective or not compliant, then it should be retested to ensure compliance. Grounding system will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports. Reports shall be submitted to the OWNER and ENGINEER at time of substantial completion.

END OF SECTION

SECTION 27 05 28

TELECOMMUNICATIONS PATHWAYS AND SPACES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Telecommunications vertical and horizontal pathways.
2. Backboards and mounting elements.
3. Telecommunications equipment racks and cabinets.
4. Telecommunications service entrance pathways.
5. Grounding.

1.2 RELATED SECTIONS

06 61 00 – Rough Carpentry

07 81 13 – Penetration Firestopping

09 91 23 – Interior Painting

26 05 26 – Grounding and Bonding for Electrical Systems

26 05 33 – Raceway and Boxes for Electrical Systems

26 05 53 – Identification for Electrical Systems

27 13 00 – Communications Backbone Cabling

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. ANSI/TIA - 568-D Telecommunications Pathways and Spaces, 2015.

C. ANSI/TIA - 568-D.0 Generic Telecommunications Cabling for Customer Premises, 2015.

D. ANSI/TIA - 568-D.1 Commercial Building Telecommunications Cabling Standard, 2015.

E. ANSI/NECA/BICSI 568-2006 - Standard for Installing Commercial Building Telecommunication Cabling.

F. ANSI/TIA - 942-A Telecommunications Infrastructure Standard for Data Centers, 2014.

G. ANSI/TIA - 606-B Administration Standard for Telecommunications Infrastructure, 2012.

H. ANSI/TIA - 607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, 2015.

I. NFPA 70 - National Electric Code, 2008, 2014, 2017.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.

3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: For each qualified layout technician, installation supervisor, and field inspector.

D. Seismic Qualification Certificates: For floor-mounted cabinets, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician (BICSI), who shall be present at all times when Work of this Section is performed at Project site.

3. Field Inspector: Currently registered by BICSI as an RCDD to perform the onsite inspection.

4. CONTRACTOR must be certified prior to time of bid with the manufacturer, and must be able to provide a complete system warranty for products installed by the listed manufacturers.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with ANSI/TIA/EIA-569-B.

D. Grounding: Comply with ANSI-J-STD-607-A.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. EIA: Electronic Industries Alliance.

D. TIA: Telecommunications Industry Association.

E. ANSI: American National Standard Institute.

F. RCDD: Registered Communications Distribution Designer.

1.8 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Floor-mounted cabinets, racks and cable pathways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7, (Zone 4).

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and associated construction work on the subfloor and raised floor supports is substantially complete.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with ANSI/TIA/EIA-569-B.

B. Cable Support (J-Hook): Cable installation that does not require basket cable tray management but shall require support of cables with J-Hooks. J-Hook pathway support will be spaced no more than 60 between supports.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Erico Caddy

b. B-Line

c. CTS

d. Stiffy

e. Panduit

2. 2. Cable Support Materials (J-Hook) shall meet or exceed the below characteristics of construction and features.

a. Provide broad based support for cabling to aid in maintaining overall system performance.

b. Be available in 50.8mm (2”) and 101.6mm (4”) options.

c. Come equipped with a cable retention clip.

d. Offers a full line of mounting accessories.

C. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cablofil Inc.

b. Cooper B-Line, Inc.

c. WBT Wire Basket Tray.

2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick.

a. Basket Cable Trays: Provide tray widths as noted - 4 - 24 inches - wide and minimum 2 inch deep. Wire mesh spacing shall not exceed 2 by 4 inches.

D. Ladder Rack:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Chatsworth

b. RXL

2. Description:

a. Size: 1.5 inches high by 0.4 inches wide high tubular steel with 0.065 inch wall thickness.

b. Stringers: 9 feet 11-1/2 inches long.

c. Cross Members: Welded in between stringers on 12 inch intervals/centers beginning 5-3/4 inches with 10 cross members per ladder rack. Open space of 10-1/2 inches between each cross member.

d. Finish and Color: Powder coat paint in black.

e. Provide cable tray widths as noted, 12” - 24” wide.

E. Conduit and Boxes: Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems."

F. Conduit Sleeves: Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems."

G. Conduit and Boxes (Wireless Access Points): Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems". Provide a 1” conduit and two gang box, coordinated with the finished height of a hard lid ceiling for outlet mounting, and extend the conduit to the nearest cable tray.

2.2 BACKBOARDS

A. Backboards: Provide plywood, fire-retardant treated, 3/4 by 48 by 96 inches, on at least two of the full non-door walls of each telecommunications room, or as noted. Comply with requirements for plywood backing panels specified in Section 06 61 00 "Rough Carpentry."

2.3 EQUIPMENT FRAMES 2 POST

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Siemon RS1-07-S.

B. General Frame Requirements:

1. Mounting Channels: 3 inches deep and punched on the front and rear flange with the EIA-310-D Universal hole pattern.

2. UL and cUL Listed as a Communications Circuit Accessory, DUXR and DUXR7 category, file number 140851.

3. Size: 7 feet, 45U by 19 inch EIA in black.

4. Capacity; 1000 lb.

5. lock.

2.4 CABLE MANAGEMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Siemon VCM-10.

2. Siemon HCM-6-2U.

B. Cable Management for Equipment Frames:

1. Shall consist of a metal backbone, with cable fingers that align with EIA rack spacing.

2. Baked-polyester powder coat finish.

3. Fingers will be molded plastic, and shall provide integral bend radius control.

4. Vertical cable management panels shall have front channels, with covers.

5. Vertical cable management panels will be 10□ wide to handle Category 6A cable.

6. Horizontal cable management panels shall have front channels with covers, and shall be a minimum height of two rack units each.

7. Horizontal cable management panels will be high capacity, and capable of managing Category 6A patch cords.

2.5 GROUNDING

A. Comply with requirements in Section 26 05 23"Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Telecommunications Main Ground Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32inch holes spaced 1-1/8 inches apart.

3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V. C. Comply with ANSI-J-STD-607-A.

2.6 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. CONTRACTOR shall coordinate final labeling scheme with OWNER for final approval.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Install underground pathways complying with recommendations in TIA/EIA-569-B, "Entrance Facilities" Article.

3.2 INSTALLATION

A. Install underground entrance pathway complying with Section 26 05 33 "Raceway and Boxes for Electrical Systems." Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Cable Trays: Provide overhead cable runway (basket tray) as noted. Comply with NEMA VE 2 and TIA/EIA-569-B.

1. Cable tray should be installed per manufacturer's specifications.

2. Distance between supports shall not be more than 8 feet.

3. Cable tray must be supported by a trapeze support. Cable tray cannot be center hung.

4. Provide seismic support as required by the manufacturer.

5. Cable tray cannot exceed a maximum of 40% fill ratio, and cable must not exceed 75% of the total depth of the cable tray. If cable utilizes more than 75% of the total depth the cable tray must be upsized appropriately.

D. Bundle, wrap, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install management bars and distribution spools.

3.3 FIRESTOPPING

A. Comply with requirements in Section 07 81 13 "Penetration Firestopping." Comply with TIA/EIA-569-B, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

2. Bond all racks, ladder rack, and cable tray to the grounding bus bar.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. See Evaluations for discussion of TIA/EIA standard as it applies to this Section.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration, including optional identification requirements of this standard.

E. Labels shall be preprinted or computer-printed type.

END OF SECTION

SECTION 27 05 49

HORIZONTAL DIRECTIONAL DRILLING FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Scope of Work:

1. The work specified in this section consists of furnishing and installing communications conduit using the directional boring (horizontal directional drilling, HDD) method of installation. This work shall include all services, equipment, materials, and labor for the complete installation, testing, and site restoration.

1.2 REFERENCES

A. American Society of Testing and Materials (ASTM)

1. F1962: Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings.

2. D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

B. ANSI/TIA-758: Customer-Owned Outside Plant Telecommunications Infrastructure Standard.

C. Related Bid Items:

1. 2-4" Directional Drilled Ductbank (HDPE-SDR-11).

1.3 SUBMITTALS

A. Prior to beginning of work, CONTRACTOR must submit a detailed work plan to the UTA outlining the procedure and schedule to be used to execute the project. The work plan should include a description of all equipment to be used, down-hole tools, a list of personnel and their qualifications and experience (including back-up personnel in the event that an individual is unavailable), list of sub-contractor(s), schedule of work activity, and a safety plan.

B. Submit for approval a pre-construction bore-log depicting the plan and profile (horizontal and vertical alignment) of the proposed bore path. The bore-log shall show all utility crossings and existing structures.

C. Record Drawings: Submit for UTA approval the as-built records within 5 days after completing the pull back. The as-built records shall include a plan, profile (data every 25 linear feet of main, at a minimum), and all information recorded during the progress of the work, including all subsurface anomalies identified by Ground Penetrating Radar and vacuum excavation. The HDD contractor shall certify the accuracy of all as-built record drawings.

1.4 QUALITY ASSURANCE

A. The requirements set forth in this specification specify a wide range of procedural precautions necessary to ensure that the very basic, essential aspects of a directional bore installation are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this specification. Adherence to the specifications contained herein, or the UTA's approval of any aspect of any directional bore operation covered by this specification, shall in no way relieve the CONTRACTOR of their ultimate responsibility for the satisfactory completion of the work authorized under this Contract.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PERSONNEL QUALIFICATIONS CERTIFICATION

A. Directional Boring:

1. All personnel shall be fully trained in their respective duties as part of the directional drilling crew and in safety. (Each person must have been fully trained for over 1,000 hours on all facets of directional drilling, including, but not limited to machine operations, mud mixing, locating, and material fusion.) A responsible representative who is thoroughly familiar with the equipment and type of work to be performed must be in direct charge of and control of the operation at all times. In all cases the CONTRACTOR supervisor must be continually present at the job site during the actual directional bore operation. The CONTRACTOR shall have a sufficient number of competent workers on the job at all times to ensure the directional bore is made in a timely and satisfactorily manner.

B. HDPE Joining (Heat Fusion):

1. Joints between HDPE conduit cannot be made via fusion but by connecting the conduits together and splicing the insulation resistance to each other. The CONTRACTOR shall order sizes and lengths as required to pull the correct length of SDR-11.

1.7 ENVIRONMENTAL PROTECTION

A. The CONTRACTOR shall place silt fence between all boring operations and any drainage, wetland, waterway or other area designated for such protection by Contract Documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or boring fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. The CONTRACTOR shall adhere to all applicable environmental regulations. Fuel or oil may not be stored in bulk containers within 200 feet of any waterbody, wetland or runway.

1.8 SAFETY

A. The CONTRACTOR shall adhere to all applicable state, federal and local safety regulations and all operations shall be conducted in a safe manner.

PART 2 - MATERIALS

2.1 SMOOTHWALL HDPE CONDUIT

A. Conduit: Conduit shall be manufactured to NEMA TC-7 requirements. SCH 80 4 inch Diameter Smoothwall HDPE by AD Technologies or OWNER approved equal.

1. Minimum Wall: 0.409 inches
2. Wall Tolerance: +/- 0.049 inches
3. Average ID: 3.633 inches
4. Weight (lb/ft): 2.291

B. Joints: Unless otherwise specified, provide continuous runs between manholes.

C. Conduit Markings: Per manufacturer’s recommendations.

2.2 GENERAL BORING EQUIPMENT

A. The directional boring equipment shall consist of a directional boring rig of sufficient capacity to perform the bore and pullback the pipe, a drilling fluid mixing, delivery and recovery system of sufficient capacity to complete the drill, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be re-used, a guidance system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, trained and competent personnel to operate the system. All equipment shall be in good, safety operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of the project.

2.3 DRILLING SYSTEM

A. Drilling Rig: The directional boring machine shall consist of a power system to rotate, push and pull hollow pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the crossing. The hydraulic power system shall be self-contained with sufficient pressure and volume to power boring operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations. The rig shall be grounded during boring and pull-back operations. Sufficient spares shall be kept on hand for any breakdowns which can be reasonably anticipated.

B. The bore head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and boring fluid jets.

C. Mud Motors (if required) shall be of adequate power to turn the required boring tools.

D. Drill pipe shall be constructed of high quality 4130 seamless tubing, grade D or better.

2.4 GUIDANCE SYSTEM

A. A Magnetic Guidance System (MGS) or proven gyroscopic system shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The guide shall be capable of tracking at all the depths up to 80 feet and in any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). The guidance system shall be accurate to +/- 2 percent of the vertical depth of the borehole at sensing position at depths up to 100 feet and accurate within 5 feet horizontally.

B. The guidance system shall be of a proven type and shall be set up and operated by personnel trained and experienced with the system. The operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system if using a magnetic system.

C. Bore Tracking/Monitoring: At all times during the pilot bore the CONTRACTOR shall provide and maintain a bore tracking system that is capable of accurately locating the position of the drill head in the x, y, and z axis. The CONTRACTOR shall record these data at least once per drill pipe length of every 25 feet, whichever is more frequent.

D. Surface Grid Tracking System: The CONTRACTOR shall monitor and record x, y, and z coordinates relative to an established surface survey benchmark. The data shall be continuously monitored and recorded at least once per drill pipe length or every 25 feet, whichever is more frequent.

E. Drilling Fluid Pressure/Flow Rates: Drilling fluid pressures and flow rates shall be continuously monitored and recorded by the CONTRACTOR. The pressures shall be monitored at the pump. These measurements shall be made during pilot bore drilling, reaming, and pullback operations.

2.5 DRILLING FLUID SYSTEM

A. Mixing System: A self-contained, closed, boring fluid mixing system shall be of sufficient size to mix and deliver boring fluid composed of bentonite clay, potable water and appropriate additives. The mixing system shall continually agitate the boring fluid during boring operations.

B. Drilling Fluids: Drilling fluids shall be composed of clean water and an appropriate additive. Water shall be from a clean source with a pH of 6.0. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No hazardous additives may be used.

C. Delivery System: The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used boring fluid and boring fluid spilled during boring operations shall be contained and properly disposed of. A berm, minimum of 12 inch high, shall be maintained around boring equipment, boring fluid mixing system, entry and exit pits and boring fluid recycling system (if used) to prevent spills into the surrounding environment. Pumps and/or vacuum truck(s) of sufficient size shall be in place to convey excess boring fluid from containment areas to storage facilities.

D. Drilling Fluid Recovery System: The drilling fluid recycling system shall separate sand, dirt, and other solids from the drilling fluid to render the drilling fluid re-usable. Spoils separate from drilling fluid will be stockpiled for later use or disposal.

E. Control of Drilling Fluids: The CONTRACTOR shall control operational pressures, drilling mud weights, drilling speeds, and any other operational factors required to avoid hydro-fracture fluid losses to formations, and control drilling fluid spillage. This includes any spillage or returns at entry and exit locations or any intermediate point. All inadvertent returns or spills shall be promptly contained and cleaned up in accordance with UTA procedures. The CONTRACTOR shall maintain on-site mobile spoil removal equipment during all drilling, pre-reaming, reaming and pullback operations and shall be capable of quickly removing spoils.

2.6 OTHER EQUIPMENT

A. Pipe Rollers, if required, shall be of sufficient size to fully support the weight of the pipe while being hydro tested during the pull-back operations. A sufficient number of rollers shall be used to prevent excess sagging of the pipe.

B. Hydraulic or pneumatic pipe rammers may only be used if necessary and with UTA approval.

C. Other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections shall not be used unless approved by the UTA prior to commencement of the work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete the utility placement satisfactorily without undue stoppage and to maintain line and grade within the tolerances prescribed by the particular conditions of the project.

PART 3 - EXECUTION

3.1 DRILLING PROCEDURE

A. Bore Path Survey:

1. Entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within areas indicated on drawings. If CONTRACTOR is using a magnetic guidance system, drill path will be surveyed for any surface geo-magnetic variations or anomalies.

B. Guidance System:

1. The CONTRACTOR shall provide and maintain instrumentation necessary to accurately locate the pilot hole (both horizontal and vertical displacements), measure pilot string torsional and axial and measure drilling fluid discharge rate and pressure. The UTA shall have access to these metrics at all times during operation.

C. Pilot Hole:

1. The pilot hole shall be drilled along the path shown on the plans and profile drawings or as directed by the UTA in the field. Unless approved otherwise, the pilot hole tolerances shall be as shown on the plans.

D. Pull Back:

1. After successfully reaming bore hole to the required diameter, CONTRACTOR will pull the conduit through the bore hole. In front of the pipe will be a swivel. Once pull-back operations have commenced, operations must continue without interruption until conduit is completely pulled into bore hole. During pull-back operations the CONTRACTOR will not apply more than the maximum safe pipe pull (tensile) strength at any time.

2. Torsional stress shall be minimized by using a swivel to connect a pull section to the reaming assembly.

3. The pullback section of the pipeline shall be supported during pullback operations so that it moves freely, and the pipe is not damaged.

4. External pressure shall be minimized during installation of the pullback section in the reamed hole. Damaged pipe resulting from external pressure shall be replaced at no cost to the UTA.

5. Buoyancy modification shall be at the discretion of the CONTRACTOR and shall be approved by the UTA. The CONTRACTOR shall be responsible for any damage to the pull section resulting from such modifications.

6. In the event the conduit becomes stuck, the CONTRACTOR will cease pulling operations to allow any potential hydro-lock to subside and will commence pulling operations. If conduit remains stuck, the CONTRACTOR will notify the UTA and discuss options to proceed.

3.2 PIPE ASSEMBLY

A. Conduit shall be installed together in one length, if space permits. Pipe may be placed on pipe rollers before pulling into bore hole to minimize damage to the conduit.

B. Cuts or gouges that reduce the wall thickness by more than 10 percent is not acceptable and must be discarded.

3.3 POST INSTALLATION

A. Inspect conduits for integrity and proper installation.

B. Perform as-built survey to document the installed conduit location and depth.

C. Restore the site to its original condition, including any landscaping or surface repairs.

3.4 TESTING

A. Conduct pressure testing or mandrel testing on installed conduits to verify integrity.

B. Document and submit test results for approval.

C. Proof all conduit before installation of cabling and detectable 1200-pound mule tape in any conduit that does not require the installation of innerduct or microduct.

1. Use a mandrel at least 80 percent of the conduit diameter, at least twice as long as the conduit diameter, and composed of rigid material.

2. Schedule proofing with the ENGINEER at least 5 working days in advance of performing the work.

3.5 DOCUMENTATION

A. Provide detailed documentation of the HDD process, including bore path logs, material certifications, and test results.

B. Submit as-built drawings showing the final location and depth of installed conduits.

END OF SECTION

SECTION 27 13 00

COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pathways.
2. Category 3 UTP backbone cable.
3. 8.3/125 9/125 micron, SMFO cable.
4. Cable connecting hardware, termination panels, and cross-connects.
5. Cabling identification products.

B. Related Sections:

1. Division 27 Section 27 15 00 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.2 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. TIA/EIA Standards:

1. TIA/EIA-568-C.1
2. TIA/EIA-568-C.2
3. TIA/EIA-569-B
4. TIA-598-C

C. ANSI Standards:

1. J-STD-607-A

D. ICEA Standards:

1. S-84-608-2007

E. NEMA Standards:

1. NEMA VE 2

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For all cable, include the following installation data for each type used:

a. Nominal OD.

b. Minimum bending radius.

c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by OWNER.

2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

3. Cabling administration drawings and printouts.

4. Wiring diagrams to show typical wiring schematics including the following:

a. Cross-connects.

b. Patch panels.

c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.

b. Clearances for access above and to side of cable trays.

c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For all qualified layout technicians, installation supervisors, and field inspectors.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

G. Manuals:

1. Design
2. Equipment
3. Operators

H. Maintenance Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall provide upon completion a system warranty from the manufacturer to guarantee installation of end-to-end high performance cabling systems that meet all application requirements associated with the Category of cabling installed. The system warranty shall include all copper and fiber cable and connectivity components. The system warranty shall be for a period of at least 20 years.

B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field-testing program development by a RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician by BICSI, who shall be present at all times when work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
4. CONTRACTOR must be a Siemon certified installer company prior to time of bid with the manufacturer and must be able to provide a complete system warranty for the products installed.

C. Testing Agency Qualifications:

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-B.

F. Grounding: Comply with ANSI-J-STD-607-A.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

H. NRTL: Nationally Recognized Testing Laboratories.

I. OSP: Outside Plant.

J. SMFO: Single Mode Fiber Optic.

K. ICEA: Insulated Cable Engineers Association.

L. ANSI: American national Standards Institute.

M. TIA: Telecommunications Industry Association.

N. EIA: Electronics Industries Alliance.

O. NFPA: The National Fire Protection Association.

P. OFNR: Optical fiber Nonconductive Riser.

Q. NEMA: National Electrical manufacturers Association.

R. NECA: National Electrical Contractors Association.

S. ITSIMM: Information Technology Systems Installation Methods Manual.

T. TDMM: Telecommunications Distribution Methods Manual.

U. CMR: Communications Multipurpose Cable, Riser.

V. CMP: Communication Multipurpose Cable, Plenum.

1.7 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects shall be located in termination rooms (telecom) and at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

C. Where indicated a copper backbone cabling distribution system shall be provided as depicted on the contract drawings.

1.8 BACKBONE OPTICAL FIBER CABLING DESCRIPTION

A. Where indicated a fiber optic cabling distribution system shall be provided as part of an overall campus-wide structured cabling system. The system shall be installed as depicted on the contract drawings.

1.9 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-C.1, when tested according to test procedures of this standard.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.

2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

3. Test each pair of UTP cable for open and short circuits.

B. Copper Cabling.

1. Preparation for delivery: The copper cable shall be shipped on reels in lengths as specified with a minimum overage of ten (10) percent.

a. The cable shall be wound on the reel so that unwinding can be done without kinking the cable.

b. Two (2) meters of cable at both ends of the cable shall be accessible for testing.

c. Marking: Each reel shall have a permanent label attached showing length, cable identification number, cable size, cable type, and date of manufacture. Labels shall be water-resistant and the writing on the labels shall be indelible.

2. Storage: The cable shall have a minimum storage temperature range of minus 40 degrees Celsius to plus 70 degrees Celsius.

3. Copper materials shall be delivered in original packages with labels intact and identification clearly marked. Materials damaged prior to final installation acceptance shall be replaced at no extra cost to the UTA.

C. Test fiber optical cables upon receipt at project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.

2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

3. The completed cable shall be packaged for shipment on anon-returnable wooden reels. Required cable lengths shall be stated in the purchase order.

4. The top and bottom ends of the cable shall be available for testing.

5. Both ends of the cable shall be sealed to prevent the ingress of moisture.

6. Each reel shall have a weather resistant tag attached identifying the reel and cable.

7. The reel tag shall include the following information:

a. Cable Number

b. Shipped Cable Length in Meters

c. Product Number

d. Date Cable was Tested

e. Cable Length Markings

f. Gross Weight

g. Job Order Number

h. Customer Order Number

i. Order Number

j. Item Number

8. The reel (one flange) marking shall include:

   a. Country of Origin (e.g., USA)

   b. An arrow indicating power direction of roll when handling

   c. Forklift-handling illustration

   d. “DO NOT SHIP REEL ON SIDE” or “DO NOT LAY REEL ON ITS SIDE”

9. Each cable shall be accompanied by a cable data sheet. This data sheet shall be submitted to the Airport as part of the final documentation. This cable data sheet shall include the following information:

   a. Cable Number

   b. Factory Order Number

   c. Alternate Customer

   d. Customer Purchase Order Number

   e. Mark for Information

   f. Maximum Billable Length

   g. Measured Attenuation of Each Fiber (for lengths > 1000 m)

   h. Product Number

   i. Customer Name

   j. Customer Cable Number

   k. Alternate Code

   l. Ordered Length

   m. Actual Shipped Length

   n. Bandwidth Specification (where applicable)

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Underground duct banks and Manholes: Outdoor duct banks and manholes may contain liquid. Depths vary seasonally and with recent precipitation. Liquid depths may vary from approximately 2 to 10 feet. CONTRACTOR shall be required to dewater duct banks and manholes.

C. CONTRACTOR shall be required to comply with all applicable safety regulations.

D. CONTRACTOR shall be required to comply with all Airport Badging requirements.

E. The CONTRACTOR shall be responsible for determining actual existing site conditions.

1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with OWNER's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-B.

B. Cable Support: NRTL labeled for support of Category 6A cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.

2. Lacing bars, spools, J-hooks, and D-rings.

3. Straps and other devices.

C. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cablofil Inc.

b. Cooper B-Line, Inc.

c. WBT Wire Basket Tray

2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick.

a. Basket Cable Trays: Provide tray widths as noted 4 24 inches - wide and minimum 2 inch deep. Wire mesh spacing shall not exceed 2 by 4 inches.

D. Ladder Rack:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Chatsworth

2. Description:

    a. Size: 1.5 inches high by 0.4 inches wide high tubular steel with 0.065-inch wall thickness.

    b. Stringers: 9 feet 11-1/2 inches long.

    c. Cross Members: Welded in between stringers on 12-inch intervals/centers beginning 5-3/4 inches with 10 cross members per ladder rack. Open space of 10-1/2 inches between each cross member.

    d. Finish and Color: Powder coat paint in black.

    e. Provide cable tray widths as noted 12”, 24” wide.

E. Conduit and Boxes: Comply with requirements in Division 26 Section 26 05 33 "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used. A minimum 1-inch conduit shall be provided.

1. Outlet boxes shall be two gang, 4 11/16” square x 2.5” deep, with a 5/8” single gang mud ring.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Division 06 Section 06 61 00 "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE OSP

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. General Cable

2. Superior Essex

B. Description: 50 pair, 100-ohm, multipair UTP (quantity as noted), formed into 25-pair binder groups covered with a CMR or CMP jacket.

1. Comply with ICEA S-84-608-2007.

2. Comply with TIA/EIA-568-C.1 for performance specifications.

3. Comply with TIA/EIA-568-C.2, Category 3.

4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

C. Communications: Type OSP, polyethylene (PE)89, complying with NFPA 262.

2.4 UTP CABLE RISER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. General Cable

2. Superior Essex

B. Description: 25 pair, 100-ohm, multipair UTP (quantity as noted), formed into 25-pair binder groups covered with a Communications Multipurpose Cable, Riser (CMR) or Communications Multipurpose Cable, Plenum (CMP) jacket.

1. Comply with ICEA S-84-608-2007.

2. Comply with TIA/EIA-568-C.1 for performance specifications.

3. Comply with TIA/EIA-568-C.2, Category 3.

4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

C. Communications: Type CMR or CMP, complying with NFPA 262.

2.5 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Siemon

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Riser Patch Panel: Provide Cat 5e, 24 port patch panels for backbone copper cable.

1. Number of Terminals per Field: One pair for each 8p8c connector.

D. Jacks and Jack Assemblies: Eight-position modular RJ45 receptacle units with integral IDC-type terminals.

2.6 BUILDING ENTRANCE PROTECTION

A. Voice Backbone Copper Building Entrance Terminals (BETs): Complete with lockable covers and plug-in protector modules for each pair terminated on the chassis. Gas- tube protector modules shall provide 350V over-voltage and sneak current protection. BEPs and protectors shall be manufactured by the following manufacturers:

B. Manufacturers:

1. Circa Enterprises
2. Or equal
    a. 1880ECA1 Series
        1) 26-pair to 50-pair to be terminated: 1880ECA1-50GT2
    b. Protectors shall be:
        1) 4B1E (PTC)

2.7 OPTICAL FIBER CABLE RISER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Corning
    2. Approved Equal

B. Description: Single mode fiber optic cable, (24) strand fiber, interlocking armored, tight buffer.
    1. Comply with ICEA S-83-596 for mechanical properties.
    2. Comply with TIA/EIA-568-C.3 for performance specifications.
    3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
        a. Riser Rated, Nonconductive: Type OFNR, complying with NFPA 262.

C. Description: Single mode fiber optic cable, (48) strand fiber, loose tube.
    1. Comply with ICEA S-83-596 for mechanical properties.
    2. Comply with TIA/EIA-568-C.3 for performance specifications.
    3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
        a. Riser Rated, Nonconductive: Type OFNR, complying with NFPA 262.

2.8 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Corning

B. General Fiber Specifications.

1. All fiber optic cable will meet or exceed the attenuation specification of the TIA-568-C.3 Table 1 for the relevant optical fiber type.

2. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

3. Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.

4. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m2).

5. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

6. The attenuation specification shall be a maximum value for each cabled fiber at 23 ± 5 °C on the original shipping reel.

7. All fibers in the cable must be usable and meet required specifications.

C. Fiber Optic Cable Specification, Loose Tube Design for Outdoor Installation.

1. General Considerations

a. The cable shall meet all requirements stated in this specification. The cable shall be an accepted product of the United States Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900 and meet the requirements of ANSI/ICEA Standard for Fiber Optic Outside Plant Communications Cable, ANSI/ICEA S-87-640-2006.

2. Fiber Characteristics

a. See Multi-mode and single-mode fiber specifications above, fibers must be manufactured using the Outside Vapor Deposition (OVD) method.

D. Specifications for Outdoor Cable Construction

1. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0 mm.

2. Each buffer tube shall contain up to 12 fibers.

3. The fibers shall not adhere to the inside of the buffer tube.

4. Each fiber shall be distinguishable by means of color-coding in accordance with TIA-598-C, "Optical Fiber Cable Color Coding."

5. The fibers shall be colored with ultraviolet (UV) curable inks.

6. Buffer tubes containing fibers shall be color-coded with distinct and recognizable colors in accordance with TIA-598-C, "Optical Fiber Cable Color Coding."

7. Buffer tube-colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.

8. For cables containing more than 12 buffer tubes, standard colors are used for tubes 1 through 12 and stripes are used to denote tubes 13 through 24. The color sequence applies to tubes containing fibers only and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.

9. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

10. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrink back requirements of 7 CFR 1755.900.

11. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 3.0 mm in outer diameter.

12. The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod (optional steel central member). The purpose of the central member is to provide tensile strength and prevent buckling. The central member shall be over coated with a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

13. Each buffer tube shall contain a water-swellable yarn for water-blocking protection. The water-swellable yarn shall be non-nutritive to fungus, electrically non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. This yarn will preclude the need for other water-blocking material; the buffer-tube shall be gel-free.

14. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process. Water swellable yarn(s) shall be applied longitudinally along the central member during stranding.

15. Two polyester yarn binders shall be applied contrahelically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

16. For single layer cables, a water swellable tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

17. For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two-layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

18. Non-armored cables shall contain at least one ripcord under the sheath for easy sheath removal. Armored cables shall contain at least one ripcord under the inner sheath and at least one ripcord under the steel armor for easy sheath removal.

19. Tensile strength shall be provided by the central member, and additional dielectric yarns as required.

20. The dielectric yarns shall be helically stranded evenly around the cable core.

21. Non-armored cables shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members (as required) and water swellable tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

    See Figure 1.

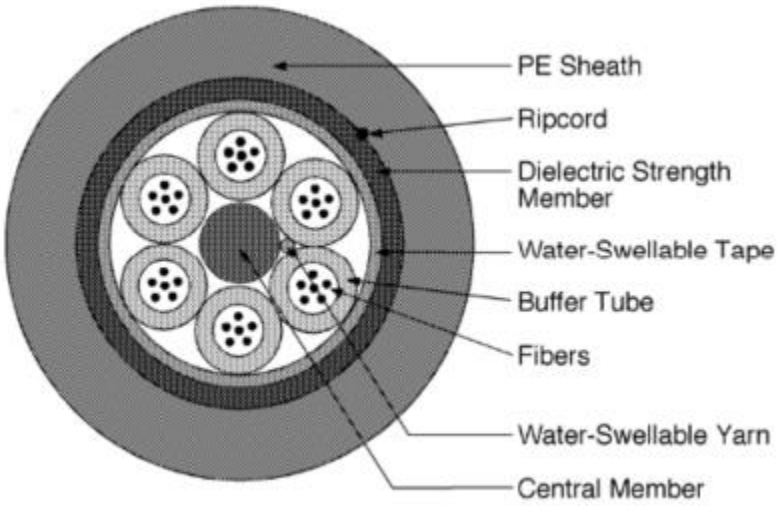

Figure 1

22. Armored cables shall have an inner sheath of MDPE. The minimum nominal jacket thickness of the inner sheath shall be 1.0 mm. The inner jacket shall be applied directly over the tensile strength members (as required) and water swellable tape. A water swellable tape shall be applied longitudinally around the outside of the inner jacket. The armor shall be a corrugated steel tape, plastic-coated on both sides for corrosion resistance, and shall be applied around the outside of the water blocking tape with an overlapping seam with the corrugations in register. The outer jacket shall be applied over the corrugated steel tape armor. The outer jacket shall be a MDPE with a minimum nominal jacket thickness of 1.4 mm. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus. See Figure 2.

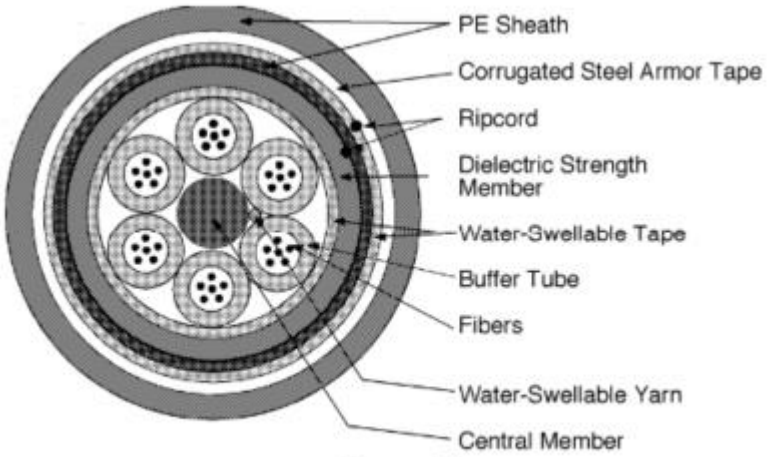

Figure 2

23. The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.

24. The jacket or sheath shall be free of holes, splits, and blisters.

25. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

26. Cable jackets shall be marked with the manufacturer's name, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code (NESC®), fiber count, and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

27. If the initial marking fails to meet the specified requirements (i.e., improper text statement, color, legibility, or print interval), the cable may be remarked using a contrasting alternate color. The numbering sequence will differ from the previous numbering sequence, and a tag will be attached to both the outside end of the cable and to the reel to indicate the sequence of remarking. The preferred remarking color will be yellow, with the secondary choice being blue.

28. The maximum pulling tension shall be 2700 N (608 lb/f) during installation (short term) and 890 N (200 lb/f) long term installed.

29. The shipping, storage, and operating temperature range of the cable shall be -40°C to +70°C. The installation temperature range of the cable shall be -30°C to +70°C.

B. Cross-Connects and Termination Panels: Single mode pigtailed splice cassette housing multiple-numbered, LC duplex cable connectors.

1. Number of Connectors per Field: One for each fiber strand or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

2. Fiber Count: 12

3. Cable Connecting Hardware:

4. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-C.3.

C. Cross-Connects and Termination Panels: Multi mode OM3 pigtailed splice cassette housing multiple-numbered, LC duplex cable connectors.

1. Number of Connectors per Field: One for each fiber strand or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

2. Fiber Count: 12

3. Cable Connecting Hardware:

4. Comply with Fiber Optic Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-C.3.

2.10 GROUNDING

A. Comply with requirements in Division 26 Section 26 05 26 “Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.11 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.12 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568-C.1.

C. Factory test UTP cables according to TIA/EIA-568-C.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA -568-C.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within cabinets. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in all spaces.

2. Comply with requirements for raceways and boxes specified in Division 26 Section 26 05 33 "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-B.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 27 11 00 "Telecommunications Pathways and Spaces." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section 26 05 33 "Raceway and Boxes for Electrical Systems" for installation of conduits and wire ways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Termination Rooms (Telecom):

1. Position vertical conduit ends adjacent to a corner where plywood backboard is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.

2. Secure conduits to backboard when entering room from overhead.

3. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch vertical dimensions. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.1.

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

3. For UTP backbone cable, install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.

8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.

10. In the communications equipment room, leave a minimum of 3 feet and no more than a 10-foot service loop on the station end of cable.

11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

12. All cables should be protected from direct paint, or incidental overspray.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-C.2.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-C.3.

2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend UTP cable not in a wire way or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60” apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section 07 84 13 "Penetration Firestopping." Comply with TIA/EIA-569-B, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section 26 05 53 "Identification for Electrical Systems."

1. Administration Class: 4.

2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Division 09 Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. See Division 27 Section 27 15 00 "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.

D. Comply with requirements in Section 27 15 00 "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular devices as shown.

b. Label each unit and field within distribution racks and frames.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA/EIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturers for channel or link test configuration.

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturers for channel or link test configuration.

        1) Link End-to-End Attenuation Tests: Horizontal and multimode backbone link measurements: Test at 1310 and 1550 nm in both directions according to ANSI/TIA/EIA 568- C standards.

        2) Attenuation test results for backbone links shall be less than 2.0 dB.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION

SECTION 27 41 00

GENERAL TECHNOLOGY SYSTEMS REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general requirements for Technology systems installations:

1. Summary of work.
2. Project Coordination.
3. References and Standards.
4. Industry Standards.
5. Allowances.
6. Unit Prices.
7. Submittals.
8. Substitutions.
9. Materials and Equipment.
10. Summary Test Report.
11. Warranties.
12. Permits.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for special product requirements.

1.2 REFERENCES

A. Related Documents:

1. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to this section of Division 27.
2. The following general and basic sections of Division 27 pertain to all system specific sections of Division 27. These general and basic information sections shall be complied with by all Technology systems contractors:

a. General Technology Systems Requirements

b. Basic Technology Systems Requirements

c. Basic Technology Systems Materials and Methods

1.3 SUBMITTALS

A. General: A unit price is an amount proposed by Bidders and stated on the Bid Form as a price per unit of measurement for materials or services that will be added to or deducted from the Contract Sum by Change Order in the event the estimated quantities of Work required by the Contract Documents are increased or decreased. Include all necessary material, overhead, profit and applicable taxes. Comply with unit price requirements identified in individual Division 27 sections.

B. Submit in accordance with Submittal Procedures Shop Drawings, Product Data and Samples.

C. General: Follow the procedures specified in Division 27 Sections under "SUBMITTALS." As a minimum, all data shall be submitted as specified and labeled as to project, date, and installer. Include Installers' signature indicating his unqualified approval that the equipment will fit in the space shown, and is complete with all requirements of the plans and specifications. Provide space for "Action" marking. Do not proceed without appropriate "Action" marking. Allow 2 weeks for review.

D. Action Stamp: The ENGINEER will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:

1. Final Unrestricted Release: Where submittals are marked "Approved," that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.

2. Final But Restricted Release: When submittals are marked "Approved as Noted," that part of the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.

3. Returned for Resubmittal: When submittal is marked "Not Approved, Revise and Resubmit," do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.

    a. Do not permit submittals marked "Not Approved, Revise and Resubmit" to be used at the Project site, or elsewhere where Work is in progress.

4. Other Action: Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, marked "Action Not Required."

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 SUMMARY OF WORK

A. The work consists of, but is not limited to, the construction of integrated audio, video, and control systems. Refer to individual Division 27 sections for additional work summaries and responsibilities.

B. OWNER furnished items: The OWNER will furnish material and equipment as indicated in the contract documents to be incorporated into the Work. These items are assigned to the installer and costs for receiving, handling, storage, if required, and installation are included in the Contract Sum.

1. The Installer's responsibilities are the same as if the Installer furnished the materials or equipment.

2. The OWNER will arrange and pay for delivery of OWNER furnished items free on board (FOB) job site and the installer will inspect deliveries for damage. If OWNER furnished items are damaged, defective or missing, document damaged items with the transport company and the OWNER will arrange for replacement. The OWNER will also arrange for manufacturer's field services, and the delivery of manufacturer's warranties and bonds to the Installer.

3. The Installer is responsible for designating the delivery dates of OWNER furnished items and for receiving, unloading and handling OWNER furnished items at the site. The Installer is responsible for protecting OWNER furnished items from damage, including damage from exposure to the elements, and to repair or replace items damaged as a result of his operations.

C. General: Comply with requirements of OWNER for completion of work. The work will be conducted to provide the least possible interference to the activities of the OWNER's personnel and operations.

1.7 PROJECT COORDINATION

A. General: Well in advance of installation of every major unit of work which requires coordination and interfacing with other work, meet at project site with installers and representatives of manufacturers and fabricators who are involved in or affected by unit of work and in its coordination and integration with other work which has preceded or will follow. Do not proceed with the work if associated pre-installation conference cannot be concluded successfully. Instigate actions to resolve impediments to performance of the work.

B. Millwork Contractor: Coordinate with the OWNER's Millwork contractor the wiring configuration, connection requirements, and dimensional layout of the furniture to be provided. Determine whether proposed furniture design will interface with Technology systems design as shown. Notify ENGINEER of any discrepancy.

1.8 REFERENCE STANDARDS AND DEFINITIONS

A. General: Basic Contract definitions are included in the General Conditions.

B. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the ENGINEER," "requested by the ENGINEER," and similar phrases.

D. Approve: The term "approved," where used in conjunction with the ENGINEER's action on the CONTRACTOR's submittals, applications, and requests, is limited to the ENGINEER's duties and responsibilities as stated in General and Supplementary Conditions.

E. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

F. Furnish: The term "furnish" is used to mean "supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations."

G. Install: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

H. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."

I. Installer: An "Installer" is the CONTRACTOR or an entity engaged by the CONTRACTOR, either as an employee, subcontractor, or sub subcontractor, for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

J. Substitutions: Requests for changes in products, materials, equipment, and methods of construction required by Contract Documents proposed by the CONTRACTOR after award of the Contract are considered requests for "substitutions."

1.9 INDUSTRY STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Where the date of issue of a referenced standard is not specified, comply with the standard in effect as of date of Contract Documents.

C. Conflicting Requirements: Where compliance with two or more standards is specified, and the standards establish different or conflicting requirements for minimum quantities or quality levels, refer requirements that are different, but apparently equal, and uncertainties to the ENGINEER for a decision before proceeding.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum, as appropriate for the context of the requirements. Refer uncertainties to the ENGINEER for a decision before proceeding.

2. Clarification methods: At the time of bidding, bidders shall familiarize themselves with the drawings and specifications. Any questions, misunderstandings, conflicts, deletions, discontinued products, catalog number discrepancies, discrepancies between the equipment supplied and the intent or function of the equipment, etc., shall be submitted to the ENGINEER in writing for clarification prior to issuance of the final addendum and bidding of the project. Where discrepancies or multiple interpretations occur, the most stringent (which is generally recognized as the most costly) that meets the intent of the documents shall be enforced.

D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents, but can be obtained through the following addresses and telephone numbers:

ANSI American National Standards Institute

11 West 42nd Street, 13th Floor

New York, NY 10036

(212) 642 3300

ASTM American Society for Testing and Materials

1916 Race St.

Philadelphia, PA 19103

(215) 299 5400

2001 Pennsylvania Ave., NW, Suite 1100

Washington, DC 20006

(202) 457 4900

ETL Testing Laboratories, Inc.

P.O. Box 2040 Route 11, Industrial Park

Cortland, NY 13045

(607) 753 6711

ICEA Insulated Cable ENGINEERs Association Inc.

P.O. Box 440

South Yarmouth, MA 02664

(617) 394 4424

IEC International Electrotechnical Commission (Available from ANSI)

1430 Broadway

New York, NY 10018

(212) 354 3300

IEEE Institute of Electrical and Electronic Engineers

345 E. 47th St.

New York, NY 10017

(212) 705 7900

NEC National Electric Code (Now NFPA)

NECA National Electrical Contractors Association

7315 Wisconsin Ave., Suite 1300 W

Bethesda, MD 20814

(301) 657 3110

NEMA National Electrical Manufacturers Association

2101 L St., NW, Suite 300

Washington, DC 20037

(202) 457 8400

NFPA National Fire Protection Association

One Batterymarch Park PO Box 9101

Quincy, MA 02269-9101

(617) 770 3000

UL Underwriters Laboratories

333 Pfingsten Rd.

Northbrook, IL 60062

(708) 272 8800

FS Federal Specification (from GSA) Specifications Unit (WFSIS)

7th and D St., SW

Washington, DC 20407

(202) 708 9205

1.10 ALLOWANCES

A. General: Follow the requirements specified in Division 1 Section "ALLOWANCES." Use the contingency allowance only as directed for the OWNER's purposes, and only by Change Orders which designate amounts to be charged to the allowance. At Project closeout, credit unused amounts remaining in the contingency allowance to OWNER by Change Order.

1.11 UNIT PRICES

A. General: A unit price is an amount proposed by Bidders and stated on the Bid Form as a price per unit of measurement for materials or services that will be added to or deducted from the Contract Sum by Change Order in the event the estimated quantities of Work required by the Contract Documents are increased or decreased. Include all necessary material, overhead, profit and applicable taxes. Comply with unit price requirements identified in individual Division 27 sections.

1.12 SUBSTITUTIONS

A. Substitution Request Submittal: Requests for substitution may be considered or rejected at the discretion of the ENGINEER, Designer, and/or OWNER.

1. Submit 3 copies of each request for substitution for consideration. Submit requests in the form and in accordance with procedures required for Change Order proposals.

2. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:

   a. Product Data, including Drawings and descriptions of products, fabrication, and installation procedures.

   b. Samples, where applicable or requested.

   c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified.

   d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the OWNER and other CONTRACTORs that will become necessary to accommodate the proposed substitution.

   e. A statement indicating the substitution's effect on the CONTRACTOR's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.

   f. Cost information, including a proposal of the net change, if any in the Contract Sum.

   g. Certification by the CONTRACTOR that the substitution proposed is equal to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the CONTRACTOR's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.

1.13 MATERIALS AND EQUIPMENT

A. Source Limitations: To the fullest extent possible, provide products of the same kind, from a single source where products are part of a single assembly.

B. Compatibility of Options: When the CONTRACTOR is given the option of selecting between two or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. If a dispute arises between CONTRACTORs over concurrently selectable, but incompatible products, the ENGINEER will determine which products shall be retained and which are incompatible and must be replaced.

C. Manufacturers: Select equipment from the manufacturers as identified in the schedules contained in the drawings.

1.14 SUMMARY TEST REPORT

A. Prepare summary test report in accordance with the requirements in each Division 27 Section. Make all tests required by the authorities having jurisdiction, by the ENGINEER and his consultants, and the OWNER. Make tests of the indicated installed conditions, and:

1. Include tests from final punch list.

2. If there are any abnormal conditions, they shall be brought to the attention of the ENGINEER in writing as a part of this submittal.

1.15 WARRANTY REQUIREMENTS

A. Reference Closeout Submittals.

B. Warranty for a minimum of one year after date of substantial completion all Technology systems equipment and workmanship. When a warranty call is requested by the OWNER, respond with an on-site service call within 24 hours of the initial call, regardless of if initial contact is made via installing company's personnel or through messaging services.

C. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the CONTRACTOR of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the CONTRACTOR.

D. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement of rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty.

E. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

F. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The CONTRACTOR is responsible for the cost of replacing or rebuilding defective Work regardless of whether the OWNER has benefitted from use of the Work through a portion of its anticipated useful service life.

G. OWNER's Recourse: Written warranties made to the OWNER are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the OWNER can enforce such other duties, obligations, rights, or remedies.

H. Rejection of Warranties: The OWNER reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

I. The OWNER reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

1.16 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.17 PERMITS, FEES

A. Obtain and pay all city, state, or local ordinance electrical permits and inspections before beginning construction.

B. Pay electric, telephone, and cable TV fees or reimbursable construction costs to the utilities in a timely manner so as not to delay construction.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

A. General Product Requirements: Provide products that comply with the Contract Documents that are undamaged and unused at the time of installation.

1. Provide products complete with all accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.

2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.

B. Product Selection Procedures: Product selection is governed by the Contract Documents and governing regulations, not by previous Project experience. Procedures governing product selection include the following:

1. Proprietary Specification Requirements: Where only a single product or manufacturer is named, provide the product indicated. No substitutions will be permitted.

2. Compliance with Standards, Codes and Regulations: Where the Specifications only require compliance with an imposed code, standard or regulation, select a product that complies with the standards, codes or regulations specified.

3. Visual Matching: Where Specifications require matching an established Sample, the ENGINEER's decision will be final on whether a proposed product matches satisfactorily.

a. Where no product available within the specified category matches satisfactorily and also complies with other specified requirements, comply with provisions of the Contract Documents concerning "substitutions" for selection of a matching product in another product category, or for noncompliance with specified requirements.

4. Visual Selection: Where specified product requirements include the phrase "...as selected from manufacturer's standard colors, patterns, textures..." or a similar phrase, select a product and manufacturer that complies with other specified requirements. The ENGINEER will select the color, pattern and texture from the product line selected.

2.2 SUBSTITUTIONS

A. Conditions: A CONTRACTOR's substitution request will be received and considered by the ENGINEER when one or more of the following conditions are satisfied, as determined by the ENGINEER; otherwise, requests will be returned without action except to record noncompliance with these requirements.

1. Extensive revisions to Contract Documents are not required.

2. Proposed changes are in keeping with the general intent of Contract Documents.

3. The request is timely, fully documented and properly submitted. All substitution requests shall be received a minimum of two weeks prior to the bid opening.

4. The request is directly related to an "or equal" clause or similar language in the Contract Documents.

5. The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly, or an unwillingness to pay special freight or factory charges to reduce the time of manufacturing.

6. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.

7. A substantial advantage is offered the OWNER, in terms of cost, time, or other considerations of merit, after deducting offsetting responsibilities the OWNER may be required to bear. Additional responsibilities for the OWNER may include additional compensation to the ENGINEER for redesign and evaluation services, increased cost of other construction by the OWNER or separate CONTRACTORs, and similar considerations.

8. The specified product or method of construction cannot be provided in a manner that is compatible with other materials, and where the CONTRACTOR certifies that the substitution will overcome the incompatibility.

9. The specified product or method of construction cannot be coordinated with other materials, and where the CONTRACTOR certifies that the proposed substitution can be coordinated.

10. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the CONTRACTOR certifies that the proposed substitution provide the required warranty.

11. Where a proposed substitution involves more than one CONTRACTOR, each CONTRACTOR shall cooperate with the other CONTRACTORs involved to coordinate the Work, provide uniformity and consistency, and to assure compatibility of products.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION PROVISIONS

A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.

B. Manufacturer's Instructions: Comply with manufacturer's installation instructions and recommendations, to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in Contract Documents.

C. Inspect materials or equipment immediately upon delivery and again prior to installation. Reject damaged or defective items. Do not repair damaged or defective items. Replace all damaged or defective items with new items.

D. Provide attachment and connection devices and methods necessary for securing Work. Secure Work true to line and level. Allow for expansion and building movement.

E. Visual Effects: Provide uniform joint widths in exposed Work. Arrange joints in exposed Work to obtain the best visual effect. Refer questionable choices to the ENGINEER for final decision.

F. Recheck measurements and dimensions, before starting each installation.

G. Install each component during weather conditions and Project status that will ensure the best possible results. Isolate each part of the completed construction from incompatible material as necessary to prevent deterioration.

H. Coordinate temporary enclosures with required inspections and tests, to minimize the necessity of uncovering completed construction for that purpose.

I. Mounting Heights: Where mounting heights are not indicated, install individual components at standard mounting heights recognized within the industry for the particular application indicated. Refer questionable mounting height decisions to the ENGINEER for final decision.

J. Internet Access: The OWNER will NOT provide internet access in the new building, or any other location for use by the AV installer during the installation.

3.2 CLEANING AND PROTECTION

A. During handling and installation, clean and protect construction in progress and adjoining materials in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

B. Clean and maintain completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

C. Limiting Exposures: Supervise construction activities to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.3 PROJECT CLOSEOUT

A. General: Comply with final punch list requirements.

B. Operating and Maintenance Instructions: Arrange for each installer of equipment that requires regular maintenance to meet with the OWNER's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:

1. Maintenance manuals.

2. Record documents.

3. Spare parts and materials.
4. Tools.
5. Identification systems.
6. Control sequences.
7. Hazards.
8. Cleaning.
9. Warranties and bonds.
10. Maintenance agreements and similar continuing commitments.

C. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

1. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
    a. Remove labels that are not permanent labels.
    b. Clean transparent materials. Replace chipped or broken lenses and other damaged transparent materials.
    c. Clean exposed exterior and interior hard surfaced finishes to a dust free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition.
    d. Wipe surfaces of all Technology equipment clean.

D. System Start Up: Provide a senior technician who is proficient with all specified systems, who is intimately familiar with this project, and who personally participated in the planning and installation of this project. Assign technician to be on site during the first day of building occupancy from 7:00 a.m. to 4:00 p.m. Technician will work closely with the OWNER's technical support personnel, and will assist the OWNER with any and all needs relative to the newly installed audio, video and control systems. Tasks will include, but not be limited to, reports of technical problems, correction of malfunctioning systems, clarification of operating instructions, and assistance with help desk calls. Include all associated costs in the base bid for this project.

E. Occupancy Adjustments: When requested by the OWNER or the A/V Consultant within one year of date of substantial completion, provide on-site assistance for any reason related to the audio, video and control system. Possible reasons for occupancy adjustments may include, but not be limited to changing levels; making minor programming changes to digital signal processors, control systems, or other similar devices; calibration of projectors; changing transformer taps or adjusting controls to suit actual occupied conditions. Include four (4) occupancy adjustment trips to the site in the base bid for this project.

END OF SECTION

Division 28 – Electronic Safety and Security

SECTION 28 46 00

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Magnetic door holders.
7. Remote annunciator.
8. Addressable interface device.
9. Digital alarm communicator transmitter.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

01 60 01 – Buy America Requirements Procedures

1.3 REFERENCES

A. National Fire Protection Association (NFPA):

B. NFPA 72: National Fire Alarm and Signaling Code

C. Underwriters Laboratories (UL)

D. UL 864: Standard for Control Units and Accessories for Fire Alarm Systems

E. Local building codes and regulations:

1. C104 – Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

1.4 DEFINITIONS

AC: Alternating Current

ADA: American with Disabilities Act

AHJ: Authority Having Jurisdiction

ASCE: American Society of Civil Engineers

C: Centigrade

dBA: Decibel Amplitude

DC: Direct Current

EEPROM: Electrically Erasable Programmable Read Only Memory

F: Fahrenheit

FACP: Fire Alarm Control Panel

HVAC: Heating, Ventilation, and Air Conditioning

OSHA: Occupational Safety and Health Administration

IBC: International Building Code

IEEE: Institute of Electrical and Electronic Engineers

LED: Light Emitting Diode

NEC: National Electric Code

NEMA: National Electrical Manufacturers Association

NFPA: National Fire Protection Association

NICET: National Institute for Certification in Engineering Technologies

NRTL: Nationally Recognized Testing Laboratory

SEI: Structural Engineering Institute

UL: Underwriters Laboratory

UTA: Utah Transit Authority

W: Watts

1.5 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only. Dependent of the application, full redundant control access across the system may be required, with a redundant fire alarm control panel (FACP) operating in a “hot standby” mode.

1.6 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 (Minimum Design Loads and Associated Criteria for Buildings and Other Structures).

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.7 SUBMITTALS

A. General Submittal Requirements:

1. In addition to the submittal to the ENGINEER, provide a complete submittal to the office of the Utah State Fire Marshal for review and approval. Incorporate Fire Marshal's corrections prior to submitting to the ENGINEER. Utah State Fire Marshal Code Books pertaining to Alarm Code; Automatic Fire Sprinkler Code; Building Code; Fire Code; and Automatic Fire Suppression Systems Code, shall be referenced and requirements applied in system design.

2. Submittals shall be approved by the Authority Having Jurisdiction (AHJ) prior to submitting them to ENGINEER.

3. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by Manufacturer in fire-alarm system design.

b. NICET-certified fire-alarm technician, Level IV minimum in Fire Alarm Systems.

c. Licensed or certified by the AHJ.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72. National Fire Alarm and Signaling Code.

2. Include voltage drop calculations for notification appliance circuits.

3. Include battery-size calculations.

4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size, ratings, and route of cable and conduits.

D. Qualification Data: For qualified Installer.

E. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Field Quality-Control Reports.

G. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Qualified personnel shall meet the certification requirements state in rule made by the Utah Fire Prevention Board in accordance with Title 63G, Chapter 3, Utah Administrative Rulemaking Act. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.

3. Record copy of site-specific software.

4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
    a. Frequency of testing of installed components.
    b. Frequency of inspection of installed components.
    c. Requirements and recommendations related to results of maintenance.
    d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.
7. Copy of NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

H. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
1. Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, National Electric Code (NEC) by a qualified testing agency and marked for intended location and application.

D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864, Control Units and Accessories for Fire Alarm Systems.

B. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to OWNER to allow scheduling and access to system and to allow OWNER to upgrade computer equipment when necessary.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.

2. Keys and Tools: One extra set for access to locked and tamper-proofed components.

3. Audible and Visual Notification Appliances: Quantity equal to 5 percent of amount of each type installed, but no fewer than 1 unit of each type.

4. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 SYSTEMS OPERATIONAL DESCRIPTION

A. The Digital, Addressable Fire Alarm System shall comply with all applicable local codes of the city and county to which they pertain, within the State of Utah, the Americans with Disabilities Act (ADA), and national codes.

B. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual fire alarm stations.

2. Heat detectors (Fixed-Temperature type; Combination Rate of Rise and Fixed Temperature type; Ionization-type).

3. Flame detectors.

4. Smoke detectors (Photoelectric).

5. Duct smoke detectors (Ionization-type).

6. Verified automatic alarm operation of smoke detectors.

7. Automatic sprinkler system water flow.

8. Heat detectors in elevator shaft and pit.
9. Fire-extinguishing system operation.
10. Fire standpipe system.

C. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Recall elevators to primary or alternate recall floors.
9. Activate emergency lighting control.
10. Activate emergency shutoffs for gas and fuel supplies.
11. Record events in the system memory.

D. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.
3. Elevator shunt-trip supervision.

E. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal AC voltage at fire-alarm control unit.

6. Break in standby battery circuitry.

7. Failure of battery charging.

8. Abnormal position of any switch at fire-alarm control unit or annunciator.

9. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.

F. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.

2.2 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864, Control Units and Accessories for Fire Alarm Systems and listed and labeled by an NRTL.

a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

b. Include a real-time clock for time annotation of events on the event recorder and printer.

2. Addressable initiation devices that communicate device identity and status.

a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.

b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 80 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.

a. Initiating Device Circuits: Style E.

b. Notification Appliance Circuits: Style Z.

c. Signaling Line Circuits: Style 7.

d. Quantity of addressable devices shall not exceed 75% of signaling line circuit capacity.

2. Serial Interfaces: RS-232 ports for printers.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.

2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.

3. Sound general alarm if the alarm is verified.

4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Notification Appliance Circuit: Operation shall sound in a temporal pattern.

F. Elevator Recall:

1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.

a. Elevator lobby detectors except the lobby detector on the designated floor.

b. Smoke detector in elevator machine room.

c. Smoke detectors in elevator hoist way.

2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.

3. Heat detector in elevator machine room shall shunt trip the power to the elevator, after the elevator has moved to the recall floor.

4. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory and print out the final adjusted values on system printer.

I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

J. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.

1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711, Standard for Amplifiers for Fire Protective Signaling Systems, and be listed by an NRTL.

a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.

b. Programmable tone and message sequence selection.

c. Standard digitally recorded messages for "Evacuation" and "All Clear."

d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.

3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

K. Primary Power: 24-V DC obtained from 120-V AC service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V DC source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

L. Secondary Power: 24-V DC supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed, valve-regulated, recombinant lead acid.

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38, Manual Signaling Boxes for Fire Alarm Systems. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

2. Station Reset: Key- or wrench-operated switch.

2.4 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V DC, nominal.

2. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

4. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

5. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15° or 20° deg F (8° or 11° deg C) per minute.

b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135° or 155° deg F (57° or 68° deg C).

c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.

    b. Device type.

    c. Present average value.

    d. Present sensitivity selected.

    e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.

    b. Device type.

    c. Present average value.

    d. Present sensitivity selected.

    e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A, Smoke Detectors for Duct Application.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.

    b. Device type.

    c. Present average value.

    d. Present sensitivity selected.

e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.

4. Each sensor shall have multiple levels of detection sensitivity.

5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit. Provide for fan interlocks with fire detection system to shut down applicable fan systems in case of fire detection.

2.5 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521, Heat Detectors for Fire Protective Signaling Systems.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135° deg F (57° deg C) or a rate of rise that exceeds 15° deg F (8° deg C) per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.6 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.

B. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, individually addressed as indicated, equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

C. Horns: Electric-vibrating-polarized type, 24-V DC; with provision for housing the operating mechanism behind a grille. Comply with UL 464, Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

D. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output:

    a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.

3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.

4. Flashing shall be in a temporal pattern, synchronized with other units.

5. Strobe Leads: Factory connected to screw terminals.

6. Mounting Faceplate: Factory finished, red or white as selected by the ENGINEER.

E. Voice/Tone Notification Appliances:

1. Appliances shall comply with UL 1480, Speakers for Fire Alarm and Signaling Systems, including Accessories, and shall be listed and labeled by an NRTL.

2. High-Range Units: Rated 2 to 15 W.

3. Low-Range Units: Rated 1 to 2 W.

4. Mounting: Semirecessed.

5. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.7 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.

2. Wall-Mounted Units: Flush mounted unless otherwise indicated.

3. Rating: 120-V AC.

B. Material and Finish: Match door hardware.

2.8 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.9 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to external system or equipment.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply or loss of power.
5. Low battery.

6. Abnormal test signal.

7. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.11 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of device.

2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting: Install wall-mounted fire-alarm control units with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

1. Install seismic bracing. Comply with requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.

2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.

3. Smooth ceiling spacing shall not exceed 30 feet (9 m).

4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.

5. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.

6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilation Systems. Install sampling tubes so they extend the full width of duct.

E. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Locate detectors within 12" of sprinkler heads.

F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

G. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling and at least 84" above the floor.

I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

J. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

K. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.2 WIRING INSTALLATION

A. Wiring Method: Install all cables and wiring in metal raceways according to Division 26 Section "Raceway and Boxes for Electrical Systems." Conceal raceway except in unfinished spaces and as indicated.

B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm- initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

E. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signal from other floors or zones.

F. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.

2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.

3. Smoke dampers in air ducts of designated air-conditioning duct systems.

4. Door hold open devices on designated doors.

5. Alarm-initiating connection to elevator recall system and components.

6. Alarm-initiating connection to activate emergency lighting control.

7. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.

8. Supervisory connections at valve supervisory switches.

9. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

10. Supervisory connections at elevator shunt trip breaker.

11. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.

12. Supervisory connections at fire-pump engine control panel.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

C. Comply with NEC 760.41B, Fire Alarm Circuit. Power panels which supply power to fire alarm systems shall have disconnecting means with red identification which are identified as FIRE ALARM CIRCUIT.

3.5 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100, Powering and Grounding Electronic Equipment. Install a ground wire from main service ground to fire-alarm control unit.

3.6 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4. Specification for Sound Level Meters.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train OWNER's maintenance personnel to adjust, operate, and maintain fire-alarm system.

B. Provide maintenance schedules and procedures as per manufacturer recommendations.

END OF SECTION

Division 31 – Earthwork

SECTION 31 05 10

BOUNDARY MARKERS AND SURVEY MONUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Materials and procedures for installing boundary markers and survey monuments.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Survey notes and drawings showing:

1. All monuments found, set, reset, or replaced, describing their kind, size, and location, and giving other data relating thereto.

2. Lines of survey, concrete structures containing reference marks, types of marks installed, distances and angles from monument referenced.

3. Witness monuments, basis of bearings, bearings, length of lines to monuments or corners witnessed and scale of drawing.

4. Errors of closure and method of adjustment.

5. Memorandum of oaths and certificates.

6. Narrative describing purpose of survey.

7. Any other data necessary for the interpretation of various items and locations for points, lines, and areas shown.

B. Copies of plats filed with the County Recorder.

1.4 QUALITY ASSURANCE

A. Use a land surveyor who complies with Utah licensing law and who is acceptable to OWNER to supervise setting or resetting of monuments and boundary markers.

B. Make surveys in conformance with accepted practice of land surveying and comply with all pertinent Laws and Regulations of land survey regulatory agencies and authority having jurisdiction.

C. Ensure all boundary markers, survey monuments, and related installations are in compliance with the standards established by the Federal Geographic Data Committee (FGDC) and the National Geodetic Survey (NGS).

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PERFORMANCE REQUIREMENTS

A. Identify the land surveyor who set the marker plates and reference marks.

B. For vertical control datum, employ the North American Vertical Datum of 1988 (NAVD88).

C. Vertical Accuracy: 2nd order 1:50,000.

D. Make all individual tape measurements to the nearest 0.01 of a foot, with tape corrections for temperature, sag, suspension, etc. noted on all field notes requiring such measurements.

E. Horizontal Accuracy: 2nd order 1:50,000.

PART 2 - PRODUCTS

2.1 MONUMENT

A. Monument Post: Minimum three (3) feet long, precast or cast-in-place concrete. Make exposed surface of finished monument posts uniform, even texture, and free of holes, cracks, and chipped edges.

B. Marker Plate: Brass or bronze cap or as indicated.

2.2 FRAME AND COVER

A. Asphalt coated, heavy duty, cast iron, Section 05 56 00.

2.3 LOT LINE WITNESS MARKER

A. Brass surveyor's tag or brass nail set in a lead filled hole in concrete.

2.4 REBAR CORNER MARKER

A. No. 5 rebar, at least 18 inches long with the top fitted with a nonferrous survey cap and stamped with land surveyor's registration number.

2.5 PIPE CORNER MARKERS

A. One (1) inch internal diameter galvanized steel pipe at least 18 inches long, or two (2) inches internal diameter galvanized steel pipe at least 36 inches long.

B. Fit pipe with concrete or mortar plug, tagged with surveyor's license number.

C. Fix tag in concrete or mortar plug with a one (1) inch minimum long bent brass brad.

2.6 FIELD NOTE PAPER

A. Twenty (20) pound bond paper minimum with format of documents acceptable to OWNER.

2.7 CONCRETE

A. Cast-in-place: Class 4000, Section 03 30 00 “Cast In Place Concrete”, or

B. Precast: Class 5000, Section 03 40 00.

PART 3 - EXECUTION

3.1 PREPARATION

A. Locate and preserve utilities, Section 31 23 16 “Excavation.”

B. Excavation, Section 31 23 16 “Excavation.”

3.2 HORIZONTAL CONTROL

A. Set base horizontal ground control upon a minimum of two (2) United States Coast and Geodetic Survey triangulation stations or equivalent, and tie to the Lambert Conformal Conic Projection for establishment of the State Plane Coordinate System with local datum adjustment within the Project area.

3.3 BEARING BASE

A. Refer all directional measurements to one "bearing base". Actual measurements may be equated to bearings and linear measurements shown on any record (i.e., plat, official map, description, or approved field notes of lines resurveyed that are shown on such records used in the survey).

3.4 TIE TO EXISTING MONUMENTS

A. Tie into a monument which has State Plane Coordinates if the monument is within 1/2 mile of the proposed survey site or at a selected location.

3.5 CORNER MARKERS

A. Site Boundary: Install pipe corner markers.

B. Lot Boundary: Install rebar corner markers for lot corners. Do not use rebar where pipe corner markers are installed as a boundary marker and a corner marker.

3.6 LOT LINE WITNESS MARKER

A. Witness lot lines by installing 1/2 inch surveyor tags in sidewalk. If sidewalk does not exist, install tags in curb or mass concrete.

3.7 MONUMENTS

A. Locate monument post so reference point falls within 1 inch diameter circle in the center of marker plate. Install marker plate in survey monument post before the concrete has acquired its initial set.

B. Compact backfill to 95 percent or greater relative to a modified proctor density, Section 31 23 26 “Compaction.”

C. Set top of frames and covers 1/4 inch lower than Pavement surface. Recess marker plate a minimum of four (4) inches below cover.

D. Install monument so frame and cover does not contact monument or marker plate.

3.8 DAMAGED MONUMENTS

A. Replace survey control monuments that are disturbed or destroyed by CONTRACTOR.

B. If OWNER allows replacement of lost or destroyed survey control monuments, use a licensed land surveyor to re-establish control monuments based upon original survey control.

3.9 REFERENCE MARKS

A. Section 01 71 34.

3.10 MAINTENANCE AND PRESERVATION

A. Establish and implement a maintenance plan to ensure the long-term preservation of boundary markers and survey monuments.

B. Regularly inspect and assess the condition of boundary markers and survey monuments, and schedule maintenance or replacement as needed.

C. Document and report any damage or discrepancies to the appropriate authorities promptly.

END OF SECTION

SECTION 31 05 13

COMMON FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Common fill material. Earth or aggregate materials used in railway and roadway construction for backfilling, subgrade preparation, and other applications.

1.2 REFERENCES

A. ASTM Standards:

1. C136 Sieve Analysis of Fine and Coarse Aggregates.
2. D448 Classification for Sizes of Aggregate for Road and Bridge Construction.
3. D1883 CBR (California Bearing Ratio) of Laboratory-Compacted Soils.
4. D2487 Classification of Soils for Engineering Purposes.
5. D2844 Resistance R-Value and Expansion Pressure of Compacted Soils.
6. D3282 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.
7. D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
8. F1647 Organic Matter Content of Putting Green and Sports Turf Root Zone Mixes.

1.3 SUBMITTALS

A. General. If a change in source of material is required, submit name of Supplier, source and gradation analysis of material before delivery to site.

B. Topsoil. Submit certification from topsoil Supplier assuring topsoil product meets requirements in this Section.

C. Borrow, granular borrow, granular backfill borrow, recycled fill, sand, gravel. Before delivering material to site, identify:

1. Name of Supplier and source.
2. Gradation, classification and CBR.
3. Percent composition of reclaimed bituminous concrete or Portland cement concrete included in the mix.

D. Slag, pumice, scoria. Identify name of Supplier, source, and density.

1.4 QUALITY ASSURANCE

A. Use a laboratory that complies with ASTM D3740 and Section 01 45 00 “Quality Control” requirements.

B. Reject fill products that do not meet requirements of this section.

C. Remove product found defective after installation and install acceptable product at no additional cost to OWNER.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by Lot. One (1) lot is one (1) day production.

2. Dispute resolution, Section 01 35 10.

B. Roadway Backfill: Sub-lot size is 5,000 tons.

C. Criteria: Acceptance of fill material is based on compliance with specified requirements, successful laboratory test results, and approval from the ENGINEER.

PART 2 - PRODUCTS

2.1 BORROW

A. Classifications A-1-a through A-4, ASTM D3282.

2.2 GRANULAR BORROW

A. Description: Granular materials, including sand and gravel, used for backfilling and subgrade preparation in railway construction.

B. Classifications A-1-a, A-1-b, A-2-4, or A-3, ASTM D3282.

C. Material meets design CBR-value (ASTM D1883) or R value (ASTM D2844) for suitability of source, not for project control testing.

2.3 GRANULAR BACKFILL BORROW

A. Description: Well-graded granular materials with a maximum particle size of two (2) inches, used for backfilling in railway construction.

B. Classification A-1, ASTM D3282.

C. Well graded.

D. Particle size, two (2) inch maximum.

E. Material meets design CBR-value (ASTM D1883) or R value (ASTM D2844) for suitability of source, not for project control testing.

2.4 RECYCLED FILL

A. Description: Materials obtained from the recycling of Portland cement concrete or bituminous concrete pavement, used for backfilling and subgrade preparation in railway construction.

B. Material: Pulverized Portland cement concrete, pulverized bituminous concrete pavement or combination, either mixed with or not mixed with a new aggregate.

C. Gradation: Meet requirements of this section based upon use, e.g. borrow, granular borrow, granular backfill borrow, etc.

2.5 NATIVE

A. Description: Earth materials obtained from excavation on the project site, used for backfilling and subgrade preparation in railway construction when permitted by the ENGINEER.

B. When allowed by ENGINEER, material obtained from Excavations may be used as fill, provided organic material, rubbish, debris, and other objectionable materials are removed, and CONTRACTOR has submitted the appropriate proctor density data (see Section 31 23 26 Compaction).

2.6 CLAY

A. Description: Fine-grained soil materials with high plasticity, used for backfilling and subgrade preparation in railway construction.

B. Classification CL, CL-ML, or ML, ASTM D2487.

C. Free of organic matter, frozen material, debris, rocks, and deleterious materials.

D. Homogeneous, relatively uniform.

2.7 SAND

A. Description: Fine granular materials, typically sourced from riverbanks, used for backfilling and subgrade preparation in railway construction.

B. Friable river or bank aggregate, free of loam and organic matter. Graded as follows.

Percent Passing	
Sieve	**By Weight**
3/8	100
100	1 - 10

2.8 GRAVEL

A. Description: Coarse granular materials, consisting of rock, stone, or other high-quality mineral particles, used for backfilling and subgrade preparation in railway construction.

B. Gradation: Include a table showing the required gradation for gravel.

C. Material: Rock, stone, or other high quality mineral particle or combination.

Sewer Rock.

Nominal Size	ASTM Size No.
3.5 to 1.5”	1
2.5 to 1.5”	2
2 to 1”	3
1.5 to 3/4”	4
1 to 1/2”	5

Pea Gravel.

Nominal Size	ASTM Size No.
3/4 to 3/8”	6
1/2 to No. 4	7
3/8 to No. 8	8
No. 4 to No. 16	9
No. 4 (screenings)	10

2.9 TOPSOIL

A. Description: Surface soil layer, rich in organic matter and nutrients, used for landscaping and site restoration in railway construction projects.

B. Chemical Characteristics:

1. Acidity and alkalinity range: pH 5.5 to 7.7
2. Soluble Salts: Less than 2.0 mmhos/cm
3. Sodium Absorption Ratio (SAR): less than 3.0
4. Nitrogen (NO_3N): 48 ppm minimum
5. Phosphorus (P): 11 ppm minimum
6. Potash (K): 130 ppm minimum
7. Iron (Fe): 5.0 ppm minimum

C. Physical Characteristics:

1. Fertile, loose, friable.

2. Free of weeds, subsoil, lumps or clods of hard earth, plants or their roots, sticks, toxic minerals, chemicals and stones greater than 1-1/2 inch diameter.

3. Composition, ASTM D2487:

Material	Percent
Sand	15 – 60
Silt	10 – 70
Clay	5 – 30
Organic matter	2 – 5

Humus determined by ASTM F1647. Peat may be used as an organic amendment to meet the humus requirements.

2.10 SLAG, PUMICE, SCORIA

A. Description: Alternative lightweight fill materials, with unique properties such as high porosity and low density, used for backfilling and subgrade preparation in railway construction when conventional materials are unsuitable or unavailable.

B. Chemically inert, porous, durable, free draining.

Table 1 – Gradation and Density

Criteria		Slag	Pumice	Scoria
Gradation, US Sieve	3”	100	100	100
	1 1/2"	80 – 100	80 – 100	80 – 100
	3/4"	20 – 100	--	--
	3/8”	0 – 20	0 – 20	40 – 100
	No. 4	0 – 10	0 – 10	10 – 70
	No. 16	--	0 – 65	0 – 40
	No. 50	--	0 – 40	0 – 25
	No. 200	0 – 3	0 – 3	0 – 15
Density, pound per cubic foot		85 – 100	75 – 80	60 – 75

NOTES:

1. Gradations are based upon percent of material passing sieve by weight, ASTM C136.

2. Density measured as in-place target.

SOURCE QUALITY CONTROL

C. Verify gradation, ASTM C136.

D. Select samples on a random location and time basis.

E. If tests indicate materials do not meet specified requirements, change materials and retest at no additional cost to OWNER.

PART 3 - **EXECUTION NOT USED**

END OF SECTION

SECTION 31 05 15

CEMENT TREATED FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Controlled low-strength material (CLSM) requirements.
2. Cement-treated fill (CTF) materials, including CLSM, lean concrete, lime-treated fill, and asphalt-treated fill.

1.2 REFERENCES

A. ASTM Standards:

1. C25 Chemical Analysis of Limestone, Quicklime, and Hydrated Lime.
2. C33 Concrete Aggregates.
3. C39 Compressive Strength of Cylindrical Concrete Specimens.
4. C51 Terms Relating to Lime and Limestone (As Used by the Industry).
5. C110 Physical Testing of Quicklime, Hydrated Lime, and Limestone.
6. C150 Portland Cement.
7. C260 Air-Entraining Admixtures for Concrete.
8. C494 Chemical Admixtures for Concrete.
9. C595 Blended Hydraulic Cement.
10. C618 Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
11. D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
12. D4832 Preparation and Testing of Soil-Cement Slurry Test Cylinders.

1.3 SUBMITTALS

A. Material Analysis: Provide a material analysis report for cement, aggregates, admixtures, and any other materials used in cement-treated fill mixtures. Include the source of the materials, conformance to the specified ASTM standards, and any additional information required by the ENGINEER.

B. Mix design: Submit a mix design for each type of cement-treated fill material to be used on the project. Include the proportions of all materials, as well as any applicable test results demonstrating compliance with the specified requirements.

1.4 QUALITY ASSURANCE

A. Maintain a quality management system that covers the entire process of handling, storage, and installation of cement-treated fill materials.

B. Use a laboratory that complies with ASTM D3740 and Section 01 45 00 “Quality Control” requirements.

C. Reject fill products that do not meet requirements of this section.

D. Remove product found defective after installation and install acceptable product at no additional cost to OWNER.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by lot. One (1) lot is one (1) day production.

2. If non-complying fill material has been installed and no bid or negotiated price for the material is specified, apply pay adjustment against cost of work requiring CLSM as part of its installation. Section 01 29 00 “Payment Procedures.”

3. Dispute resolution, Section 01 35 10.

B. Lime or Asphalt Cement Treated Backfill: Data sheet.

C. Cement Treated Flowable Fill:

1. Sublot Size:

a. Trench backfill, 100 cubic yards.

b. Roadway backfill, 250 cubic yards.

2. Strength: At ENGINEER’s discretion and ASTM C39, a lot with deficient sub-lot strength may be accepted on a pay reduction basis (Section 01 35 10), or accepted at 50 percent pay if a sub-lot is in Reject, or the lot shall be removed and replaced.

Pay Factor	PSI Below 28-day Compressive Strength
1.00	Less than 60
0.75	60 – 120
Reject	Greater than 120

1.6 SAFETY

A. Follow all applicable safety regulations and guidelines related to the handling, storage, and installation of cement-treated fill materials. Implement appropriate safety measures to protect personnel and property from potential hazards associated with cement-treated fill materials.

B. Protect persons and property from lime or quicklime handling.

PART 2 - PRODUCTS

2.1 CEMENT TREATED FLOWABLE FILL

A. Cement: Use Types I or II cement (ASTM C150) for general applications. Use Types IP or IS cement (ASTM C595) for projects with specific performance requirements, as directed by the ENGINEER.

1. Types I or II, ASTM C150.

2. Types IP or IS, ASTM C595.

B. Aggregate: Non-plastic sand, ASTM C33.

C. Water: Non-detrimental.

D. Admixtures: As needed for strength and flowability. Limit the use of chemical admixtures to those that are necessary for achieving the required strength and flowability of the cement-treated fill. All admixtures must be compatible with the cement and aggregate materials and must not have any detrimental effects on the performance or environmental impact of the cement-treated fill.

1. Pozzolan (fly ash), ASTM C618.

a. Class C or Class F.

b. Loss on ignition plus or minus three (3) percent.

2. Air: Four (4) percent to 35 percent, ASTM C173.

E. Strength: 60 psi maximum in 28 days, ASTM D4832.

2.2 LEAN CONCRETE

A. Physical Characteristics: Ensure that lean concrete mixtures meet the requirements for durability and freeze-thaw resistance, as specified by the ENGINEER.

1. Cement: Type II, ASTM C150.

2. Slump: One (1) to four (4) inches.

3. Strength: 750 psi plus or minus 100 psi in seven (7) days.

B. Aggregate: Non-plastic, crushed, Section 03 30 00 “Cast In Place Concrete”. Submit substitute gradations for acceptance before beginning construction. Do not substitute gradations without approval.

2.3 LIME TREATED FILL

A. Aggregate: Non-plastic Aggregate base course, Section 32 11 23; or Common fill, Section 31 05 13.

B. Water: Non-detrimental.

C. Lime: Dry hydrated lime or quicklime, ASTM C25, ASTM C51, and ASTM C110:

1. Minimum Chemical Composition:

   a. Hydrated Lime ($Ca(OH)_2$): 85 percent of chemical.
   b. Quicklime (CaO): 90 percent of chemical.

2. Gradation: ASTM C136. Percent passing by weight.

Table 1 - Hydrated Lime and Quicklime

Sieve	Hydrated Lime ($Ca(OH)_2$)	Quicklime (CaO)
No. 4	100	100
No. 30	95 – 100	–
No. 100	–	0 – 20
No. 200	75 – 100	–

NOTES:

1) Hydrated Lime: Washed sample for 15 minutes plus or minus 1 minute, ASTM C110.

2) Quicklime: Dry sieve only.

2.4 ASPHALT TREATED FILL

A. Cement: Use medium-setting emulsified asphalt for general applications. Use medium-cure cutback asphalt for projects with specific performance requirements, as directed by the ENGINEER.

1. Medium-setting emulsified asphalt, Section 32 12 03 “Asphalt Binders.”

2. Medium-cure cutback asphalt, Section 32 12 03 “Asphalt Binders.”

B. Aggregate:

1. Non-plastic aggregate base course, Section 32 11 23 “Aggregate Base Courses.”

2. Common fill, Section 31 05 13 “Common Fill.”

3. RAP, Section 32 12 16.18.

C. Water: Non-detrimental.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Cement Treated Fill (Flowable Fill):

1. Mold three (3) test cylinder, ASTM D4832. Test cylinders at 28 days.

2. If a cylinder test shows improper sampling, molding, handling, curing, or testing, discard the cylinder. Use remaining cylinders to determine average strength.

3. Perform sampling and testing at a frequency specified by the ENGINEER for each type of cement-treated fill material.

4. In the event of non-compliant test results, follow the corrective action procedures specified by the ENGINEER.

3.2 INSTALLATION

A. For each type of cement-treated fill material, follow the installation procedures specified by the ENGINEER, including compaction methods, lift thickness, and curing procedures.

END OF SECTION

SECTION 31 05 19

GEOTEXTILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Geotextile fabrics: separation, stabilization, filtration, and drainage applications.

1.2 REFERENCES

A. ASTM Standards:

1. D146 Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing.
2. D276 Identification of Fibers in Textiles.
3. D882 Tensile Properties of Thin Plastic Sheeting.
4. D3786 Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Tester Method.
5. D4354 Sampling of Geotextiles for Testing.
6. D4355 Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon - Arc Type Apparatus).
7. D4491 Water Permeability of Geotextiles by Permittivity.
8. D4533 Trapezoid Tearing Strength of Geotextiles.
9. D4632 Breaking Load and Elongation of Geotextiles (Grab Method).
10. D4751 Determining Apparent Opening Size for a Geotextile.
11. D4759 Determining Specification Conformance of Geosynthetics.
12. D4833 Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
13. D4873 Identification, Storage, and Handling of Geotextiles.
14. E96 Water Vapor Transmission of Materials.
15. E154 Testing Materials for Use as Vapor Barriers Under Concrete Slabs and as Ground Cover in Crawl Spaces.

1.3 SUBMITTALS

A. Product data sheets for each type of geotextile, including material specifications, test results, and installation instructions.

B. Manufacturer's certificate that each fabric complies with requirements of this section.

C. Quality control plan, detailing inspection, and testing procedures for geotextile materials.

D. Submit before use:

1. Sample of geotextile.

2. Manufacturer's certificate that each fabric complies with requirements of this section.

1.4 QUALITY ASSURANCE

A. Provide manufacturer’s on-site technical supervision and assistance.

B. Ensure that geotextile materials and their installation conform to the specifications, applicable ASTM standards, and manufacturer's recommendations.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. MARV: Acronym for minimum average roll value. A statistical value of a particular test property embracing 95 percent confidence level of all possible values of that property. For a normally distributed set of data, it is approximately the mean value plus and minus two standard deviations.

B. Permittivity of geotextiles: the volumetric flow rate of water per unit cross sectional area per unit head under laminar flow conditions, in the normal direction through a geotextile.

1.7 DELIVERY STORAGE AND HANDLING

A. Label fabric, ASTM D4873 and include the product name, manufacturer, and manufacturing date. Include width, length, and package weight.

B. Store geotextiles on a flat surface, elevated from the ground, and protect them from dirt, debris, water, and direct sunlight.

C. Handle geotextiles carefully during transportation and installation to prevent damage or contamination.

D. Deliver geotextile dry, in a wrapping that protects it from the elements during shipping and storage. Keep fabric dry.

E. Protect geotextile from ultraviolet light and temperature greater than 140 deg F until application.

PART 2 - PRODUCTS

2.1 GEOTEXTILE – GENERAL

A. Ensure that geotextiles used for various applications meet the requirements of the project and are appropriate for the specific application (e.g., separation, stabilization, filtration, or drainage).

B. Use geotextiles made from high-quality, durable synthetic fibers, such as polyolefins, polyesters, or polyamides.

C. Ensure that geotextiles are resistant to ultraviolet (UV) degradation, chemical attack, rot, and mildew.

D. Stated values in this section are for non-critical, non-severe applications.

E. Fabric consists of synthetic fibers at least 85 percent by weight of polyolefins, polyesters or polyamides.

F. Resistant to chemical attack, rot, and mildew.

G. No tears or defects that adversely alter fabric's physical properties.

H. All numerical values represent minimum average roll values in the weaker principal direction.

2.2 STABILIZATION-SEPARATION GEOTEXTILES

A. Woven or non-woven fabric. Meet the following properties and survivability ratings.

Table 1 – Stabilization-Separation Geotextile

	Standard	MARV			
		Moderate		High	
		Woven	Non Woven	Woven	Non Woven
Grab tensile strength, lbs.	D4632	180	115	270	180
Grab elongation, percent	D4632	<50	>50	<50	>50
Trapezoid tear, lbs.	D4533	70	40	100	75
Puncture resistance, lbs.	D4833	70	40	100	60
Apparent opening size (AOS), US sieve, minimum.	D 4751	30	60	30	60

B. Construction Survivability

Subgrade, CBR	1		1 – 2		> 2	
Tire pressure, psi	<50	>50	<50	>50	<50	>50
6 inches cover thickness	NR	NR	H	H	M	M
12 inches cover thickness	NR	NR	H	M	M	M
18 inches cover thickness	H	M	M	M	M	M
NOTES 1. H = High; M = Medium; NR = Not Recommended						

2.3 SILT FENCE GEOTEXTILE

A. Use woven fabric. Meet standard or high-performance properties:

Table 2 – Silt Fence Geotextile

	Standard	MARV	
		Standard	High
Grab tensile strength, lbs.	D4632	90	120
Grab elongation, percent	D4632	< 40	< 40
Flux, gal/min/ft^2	D4491	15	90
Apparent opening size (AOS), US sieve, minimum.	D4751	20	30
Ultraviolet degradation, percent	D4355	70	90

NOTES

1. Percent of grab elongation retained determined after ultraviolet light and water, ASTM D4355 for 500 hours.
2. No deviation from any requirement due to presence of seams.

B. High performance fence to have tape yarns in one principle direction only.

C. Add stabilizers or inhibitors to make filaments resistant to sunlight or heat deterioration.

D. Finish edges to prevent outer yarn from pulling away from the fabric.

E. Sheets of fabric may be sewn or bonded together. Provide minimum width recommended by manufacturer.

F. Manufactured with pockets for posts, hems with cord, or with posts pre- attached using staples or button head nails.

2.4 EROSION CONTROL GEOTEXTILES

A. Class A erosion control applications are those where the geotextile is used under conditions where installation stresses are greatest (more severe than Class B), i.e., stone placement height should be no more than five (5) feet and stone weights should not exceed 250 pounds.

B. Class B erosion control applications for geotextiles are used under conditions where installation stresses are more severe than Class C, i.e., stone placement height should be less than three (3) feet and stone weights should not exceed 250 pounds.

C. Class C erosion control applications are those where the geotextile is used in structures or under conditions where the geotextile is protected by a sand cushion or by "zero drop height" placement of stone.

D. Use woven or non-woven fabric.

Table 3 – Erosion Control Geotextile

	Standard	MARV		
		Class A	Class B	Class C
Grab tensile strength, lbs.	D4632	300	200	100
Grab elongation, percent, min.	D4632	15	50	50
Puncture resistance, lbs.	D4833	100	60	30
Trapezoid tear, lb.	D4533	80	50	40
Flux, gal/min/ft^2	D4491	25	25	25
Apparent opening size (AOS), US sieve, minimum	D4751	60	60	60
Ultraviolet degradation, percent	D4355	70	70	70
Permittivity, sec.$^{-1}$	D4491	0.1	0.1	0.1

NOTES

1. Percent of grab elongation strength retained determined after ultraviolet weathering, ASTM D4355 for 500 hours.

2. Permittivity number reflects typical not minimum values for this test method only. The k value of the geotextile shall be greater than the k value of the soil.

2.5 ROADWAY PAVEMENT GEOTEXTILES

A. Sheet Fabric: Non-woven. Heat bonded only on one side to assist in preventing bleed through of tack coat and sticking of fibers to wheels of lay-down equipment.

Table 4 – Roadway Paving Geotextile			
	Standard	MARV	
		Standard duty	Heavy Duty
Grab tensile strength, lbs.	D4632	80	120
Grab elongation, percent	D4632	50	50
Asphalt retention, gal/yd^2	--	0.2	0.3
Melting point, deg F	D276	300	300
Ultraviolet degradation, percent	D4355	70	70
Apparent opening size (AOS), US sieve, minimum	D4751	60	60
NOTES 1. Percent of grab elongation retained determined after ultraviolet weathering, ASTM D4355 for 500 hours.			

B. Crack Patch Fabric: Needle-punched non-woven coated with an Asphalt Binder and a rubberized asphalt adhesive.

Table 5 – Crack Patching Geotextile		
	Standard	MARV
Strip tensile, lbs/in.	D882	50
Puncture resistance, lb	E154	200
Permeance, perms	E69 Method B	0.10 (max)
Pliability	D146	No crack in fabric or rubberized asphalt
NOTES (a) Strip tensile uses 12 inch/minute test speed and 1-inch initial distance between grips. (b) Pliability uses 180-degree bend on 1/4 inch mandrel at –25 deg F		

2.6 DRAINAGE GEOTEXTILES

A. Class A drainage applications are for fabrics where installation stresses are more severe than Class B, i.e. very coarse sharp angular aggregate is used, a heavy degree of compaction (greater than or equal to 95 percent relative to a standard proctor density, Section 31 23 26 “Compaction”) is specified, or depth of trench is greater than 10 feet deep.

B. Class B drainage applications are those where fabric is used with smooth graded surfaces having no sharp angular projections, no sharp angular aggregate, compaction requirements are light, (less than 95 percent standard proctor, Section 31 23 26 “Compaction”), and trenches are less than 10 feet deep.

C. Use non-woven fabric.

Table 6 – Drainage Geotextile			
		MARV	
	Standard	Class A	Class B
Grab tensile strength, lbs.	D4632	200	100
Grab elongation, percent, minimum	D4632	50	50
Puncture strength, lbs.	D4833	60	30
Trapezoid tear, lbs.	D4533	50	40
Flux, gal/min/ft^2	D4491	25	25
Apparent opening size (AOS), US sieve, minimum.	D4751	60	60
Permittivity, sec.$^{-1}$ (b)	D4491	0.1	0.1

NOTES

1. Percent of grab elongation retained determined after ultraviolet weathering, ASTM D4355 for 500 hours.
2. Permittivity number reflects typical not minimum values for this test method only. The k value of the geotextile shall be greater than the k value of the soil.

2.7 WEED BARRIER GEOTEXTILE

A. Use non-woven fabric.

Table 7 – Weed Barrier Geotextile		
		MARV
	Standard	Standard
Grab tensile strength, lbs.	D4632	90
Grab elongation, percent, minimum	D4632	50
Puncture strength, lbs.	D4833	25
Trapezoid tear, lbs.	D4533	30
Apparent opening size (AOS), US sieve, minimum.	D4751	50
Ultraviolet degradation, percent	D4355	70

NOTES

1. Percent of grab elongation retained determined after ultraviolet weathering, ASTM D4355 for 500 hours.

2.8 POSTS

A. Minimum length, four (4) feet.

B. Steel: Round, U shaped, T shaped, or C shaped with a minimum weight of 1.3 pounds per foot and have projections for fastening wire.

C. Wood:

1. Soft wood posts at least three (3) inches in diameter, or nominal 2 x 4 inches and straight to provide a fence without noticeable misalignment.

2. Hard wood post providing a minimum cross-sectional area of 2.25 square inches.

D. Fasteners for Wood Posts:

1. Wire staples No. 17 gage minimum with a crown at least 3/4 inches wide and legs at least 1/2 inch long.

2. Nails 14 gage minimum, 1 inch long with 3/4-inch button heads.

2.9 SOURCE QUALITY CONTROL

A. Sampling practices, ASTM D4354.

B. Conformance verification, ASTM D4759.

PART 3 - EXECUTION

3.1 STABILIZING POOR LOAD BEARING SOILS

A. Remove all organic material larger than 1 inch in diameter from the subgrade and grade to elevations required for overlaying backfill.

B. Compact subgrade to the extent allowed by substrate condition.

C. Roll fabric onto subgrade so subgrade remains smooth. Do not drag.

D. Fold or overlap geotextile in direction of drainage.

Table 8 - Geotextile Overlap

Soil CBR Rating	Overlap Required	
	Unsewn, inches	Sewn, inches
Less than 1	--	4
1 - 2	36	4
2 - 3	30	3
3 - 5	24	--
Greater than 5	18	--

NOTES

1. Sewn seams both factory and field seams shall conform to 90 percent of the grab tensile strength requirements.

E. Place granular material on top of fabric and spread carefully to insure no puncture. Minimum backfill lift on fabric, six (6) inches.

F. Cover fabric with 12 inches of sand before placing rock larger than four (4) inches diameter on fabric.

G. Avoid sudden stops or turning motions by equipment operating on aggregate placed over the fabric.

H. Compact backfill soils over fabric to 95 percent or greater relative to a standard proctor density, Section 31 23 26 “Compaction.”

I. Repair any puncture by covering with new fabric using the same overlap dimensions indicated in Table above.

J. The CONTRACTOR shall consult with the geotextile manufacturer for appropriate geotextile selection, installation procedures, and any additional precautions specific to the site conditions.

3.2 SILT FENCE

A. Beginning work means acceptance of existing conditions.

B. The quantity of temporary silt fences may be increased, decreased, or eliminated entirely at CONTRACTOR's discretion at no additional cost to OWNER. Maintain the silt fence until the Work is accepted or until the fence and silt accumulations are removed.

C. Clear area of any debris and obstructions that may damage geotextile.

D. Place post in all low points.

E. Install posts a maximum of eight (8) feet apart with at least 18 inches in the ground. If not possible to achieve depth, secure posts to prevent overturning.

F. Attach filter fabric by wire, cord, pockets, staples, nails, or other effective means:

1. When using a wire support fence, provide at least six (6) horizontal wires with a minimum of 12 gage wire. Space vertical wires six (6) inches maximum. Secure geotextile to the up slope side of the post. Extend wire into the Trench a minimum of two (2) inches and extend a maximum of 36 inches above the ground surface.

G. Install fabric so six (6) to eight (8) inches of fabric is left at the bottom to be buried. Splice together only at support posts with a minimum overlap of 18 inches. Extend buried portion six (6) inches deep and the rest upstream of the fabric fence.

H. Sediment Removal: Remove sediment before deposit reaches 1/2 of the height of the silt fence, or extend height of silt fence. After removal of sediment, dress landscape.

I. Schedule of Locations: Typical locations include the toe of fill slopes, the downhill side of fill slopes, the downhill side of large cut areas, and at natural drainage areas. Limit geotextile materials to handle an area equivalent to 1,000 square feet per 10 feet of fence. Use caution should site slope be steeper than 1:1, and water flow rates exceed 1 cubic foot per second per 10 feet of fence face.

3.3 EROSION CONTROL

A. Install fabric in locations shown on the Drawings.

B. Unless specified elsewhere, overlap geotextile at least 2 feet (2) at all longitudinal and transverse joints, or the geotextile shall be sewn.

C. If overlapped, place geotextile so upstream sheet overlaps downstream sheet.

D. For placement on slopes, overlap the next downhill strip.

E. Anchor the geotextile by using key trenches or aprons at the crest and toe of the slope.

F. Pins, usually 18 inches in length, may be helpful in securing geotextile during installation.

G. Repair: Place patch over damaged area and extend three (3) feet beyond the perimeter of any tear or damage.

3.4 ROADWAY PAVING FABRICS

A. Preparing Bituminous Concrete Surface:

1. Brush road surface clean of debris, dust, and gravel. Remove all water from surface and allow to dry.

2. Patch holes and level uneven areas with bituminous concrete.

3. Fill cracks between 1/8 inch to 1/2 inch with asphalt cement. Allow cement to cure before geotextile placement.

4. Clean cracks larger than 1/2 inch to a depth of 3 inches and fill with bituminous concrete. Where pavement is severely cracked, rutted, deformed, or distressed, secure approval for providing a bituminous concrete leveling course before geotextile placement.

B. Tacking Bituminous Surface for Pavement Fabric: Use tack asphalt recommended by fabric manufacturer. Apply tack as follows:

1. Dry pavement surface; 0.20 to 0.30 gallons per square yard. Within street intersections, on steep grades and in zones where vehicle speed changes are commonplace, reduce the application rate to no less than 0.20 gallons per square yard.

2. Heavy duty fabrics; 0.30 to 0.40 gallons per square yard.

3. Provide a tack width equal to geotextile width plus six (6) inches.

4. Apply tack only as far in advance of geotextile installation as is appropriate to insure a tacky surface at the time of geotextile placement.

5. Allow tack time to cure with no moisture remaining before placing the geotextile and overlay.

6. Clean excess tack material from the road surface.

C. Fabric Placement:

1. Place fabric into the asphalt tack with a minimum amount of wrinkling or folding. Slit and lay flat wrinkles or folds in excess of 1 inch.

2. Shingle lap all transverse joints and slit folds or wrinkles in the direction of the paving operation.

3. Maximize geotextile contact with the pavement surface by brooming or pneumatic rolling.

4. Additional hand placed asphalt tack may be required at laps and repairs.

D. Protection and Repair:

1. Do not allow traffic except necessary construction equipment and emergency vehicles to drive on the fabric.

2. Turn paver and other vehicles gradually and keep turning to a minimum to avoid movement and damage to the geotextile. Do not permit abrupt starts and stops.

3. Remove and replace damaged geotextile with the same type of geotextile, and shingle lap the overlaps in the direction of paving.

4. The CONTRACTOR shall use appropriate equipment and methods to ensure proper adhesion between the geotextile fabric and the underlying pavement, as well as between the fabric and the new asphalt overlay. Restrict overlaps to a maximum of six (6) inches.

3.5 SUBSURFACE DRAINAGE

A. Excavate trench to size and depth indicated.

B. Cut fabric to width required and place in trench. Prevent damage to geotextile.

C. Overlap geotextile 12 inches or the full width of the trench, whichever is less at the top of trench.

D. Overlap successive pieces of geotextile a minimum of 12 inches in the direction of flow.

E. Place fill to hold fabric in place.

F. Repair any damage to geotextile by placing patches extending three (3) feet in all directions beyond the damaged area.

G. The CONTRACTOR shall confirm that the chosen geotextile has an appropriate Apparent Opening Size (AOS) of no more than 70 U.S. Sieve (ASTM D4751) to allow water to pass through while preventing soil particles from entering the drainage system.

3.6 WEED BARRIER

A. Preparation:

1. Remove sharp objects, large stones, and undesirable vegetation.

2. If placing geotextile over existing bed, cut an "X" over each plant and push geotextile under plant base. If placing over new bed, roll geotextile over soil and cut an "X" for each plant hole. Fold excess geotextile under and cover with specified landscaping materials.

B. Surface Cover: Provide at least four (4) inches of cover on all areas on the geotextile unless otherwise specified by ENGINEER. If using large landscape rock, increase thickness of cover material over geotextile to three (3) times the diameter of the largest rock material. Do not leave any portion of geotextile exposed to direct sunlight.

C. Repair: Repair immediately. Clear the damaged area plus an additional three (3) feet and apply geotextile patch.

D. Maintenance: Maintain surfaces and supply additional landscape materials where necessary, including areas affected by erosion. The CONTRACTOR shall provide a maintenance schedule for periodic inspection and maintenance of the weed barrier installation. This schedule should include the identification and treatment of any areas where weeds have penetrated the geotextile.

3.7 FIELD QUALITY CONTROL

A. Reject fabric at the time of installation, if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, handling or storage.

B. The CONTRACTOR shall provide documentation of the quality control procedures followed during geotextile installation, including any testing, inspection, or repair activities. This documentation should be submitted to the ENGINEER for review and approval.

END OF SECTION

SECTION 31 05 21

GEOGRIDS AND GEOCOMPOSITES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Geogrid and geocomposite reinforcement in embankments, over subgrades, in granular bases, and in roadway pavements.

1.2 REFERENCES

A. AASHTO Standards:

1. R50 Geosynthetic Reinforcement of the Aggregate Base Course of Flexible Pavement Structures.

2. T289 Determining pH of Soil for Use in Corrosion Testing.

B. ASTM Standards:

1. D276 Melting Point Minimum.

2. D4354 Sampling of Geotextiles for Testing.

3. D4355 Resistance to Loss of Load Capacity under UV light and Weathering.

4. D4759 Determining Specification Conformance of Geosynthetics.

5. D4873 Identification, Storage, and Handling of Geotextiles.

6. D6637 Determining Tensile Properties of Geogrid.

7. D7737 Load Transfer Capability.

8. D7748 Flexural Rigidity of Geogrids, Geotextiles and Related Products.

C. ASCE Publications:

1. Giroud, J.P., and Han, J. (2004). “Design Method for Geogrid- Reinforced Unpaved Roads. Part I – Development of Design Method.” Journal of Geotechnical and Geoenvironmental Engineering, 130 (8), 775-786.

2. Giroud, J.P., and Han, J. (2004). “Design Method for Geogrid- Reinforced Unpaved Roads. Part II – Calibration and Applications.” Journal of Geotechnical and Geoenvironmental Engineering, 130 (8), 787-797.

D. EPA Standards:

1. 9090 - Compatibility Test for Wastes and Membrane.

E. FHWA Standards:

1. NHI-09-087 Corrosion/Degradation of Soil Reinforcement for MSE Walls and Reinforced Soil Slopes.

2. NHI-10-024 Design and Construction of MSE Walls and Reinforced Soil Slopes – Volume I.

3. NHI-10-025 Design and Construction of MSE Walls and Reinforced Soil Slopes – Volume II.

F. GRI Standards:

1. GG9 Torsional Behavior of Bidirectional Geogrids When Subjected to In-Plane Rotation.

G. ISO Standards: ISO 10319 Geosynthetics - Wide-width tensile test.

1.3 SUBMITTALS

A. Submit the following at least one (1) week prior to product placement.

1. Geogrid product data and sample.

2. Geocomposite product data and sample.

3. Manufacturer’s warranty.

4. Installer’s warranty.

5. Tack coat grade.

6. Information requested by ENGINEER.

B. If a bituminous surface is placed concurrent with the reinforcement, check temperature requirements and minimum thicknesses. Submit daily report to ENGINEER. Report the following.

1. Tack temperature (minimum 4 times per day).

2. Tack application rate (minimum 4 times per day).

3. Bituminous concrete temperatures (minimum 4 times per day).

4. Bituminous concrete thickness (minimum 4 times per day using depth probe after initial breakdown rolling).

5. Average tack application rate based on yield calculation using applicator weights and measured surface area.

C. Independent laboratory test reports for geogrid and geocomposite properties, including test results for tensile strength, junction strength, and aperture stability.

1.4 QUALITY ASSURANCE

A. Pre-Placement Conference: Arrange a conference at least 48 hours prior to installation of geogrid or geocomposite. Attendees are ENGINEER, Inspector, Supplier, and installer. Discuss installation and inspection procedures and the following.

1. Location.

2. Overlap.

3. Tensioning (if required).

4. Construction equipment and installation practices.

5. Critical items that can affect design criteria or warranty.

B. Supplier or Manufacturer:

1. For embankment installations and mechanically stabilized earth (MSE) structures provide at least two (2) days of on-site supervision and technical assistance.

2. For roadway projects, provide one (1) day's on-site assistance.

1.5 ACCEPTANCE

A. Pavement Subgrade: Geogrid equivalence for subgrade stabilization should be determined based on the Giroud-Han method (this section article 1.2).

B. Roadway Structures: Geogrids utilized as part of the pavement structure should be reviewed based on the AASHTO R50.

C. MSE Structures: If CONTRACTOR requests substituting a rectangular or square geogrid for a triangular geogrid, CONTRACTOR must show the structural benefit and stability of a rectangular or square geogrid is equivalent to or better than the triangular geogrid. As a minimum the following conditions must be met.

1. For large aggregate geogrids (LAG) the aperture pitch is between and 2.2 inches.

2. For small aggregate geogrids (SAG) the aperture pitch is between 0.5 and 0.9 inches.

1.6 DEFINITIONS

A. BCG: Acronym for base course geogrid.

B. Geocomposite: Fabric composed of a geogrid and either a geotextile or a tack film.

C. LAG: Acronym for large aggregate geogrid.

D. MARV: Acronym for minimum average roll value (defined in Section 31 05 19).

E. MSE: Acronym for mechanically stabilized earth.

F. SAG: Acronym for small aggregate geogrid.

1.7 DELIVERY STORAGE AND HANDLING

A. Label, handle and store product, ASTM D4873.

B. Prevent mud, wet concrete, epoxy or other deleterious materials from coming in contact with and affixing to in-place geogrid and geocomposite materials.

C. Protect product as recommended by the manufacturer. This may include protection from ultraviolet light, moisture, high or low temperatures, or roll orientation during storage.

D. Cover product within 14 days of deployment.

1.8 WARRANTY

A. Manufacturer or Supplier: Warrant product to meet the specifications.

B. Installer: Warrant workmanship for two (2) years.

PART 2 - PRODUCTS

2.1 GEOGRIDS AND GEOCOMPOSITES – GENERAL

A. Synthetic fiber at least 85 percent by weight of polypropylene, polyethylene, polyester, polyvinyl alcohol, fiberglass, modified polymer, or polyamide.

B. Resistant to chemical attack, rot and mildew, EPA 9090.

C. No tears or defects that will adversely alter properties of product.

2.2 GEOGRID FOR EMBANKMENTS

A. For environments tested in accordance with AASHTO T289, (FHWA- NKI-09-85):

1. Polypropylene (PP) can be used where pH is 3 or greater. Do not use when pH is below 3.

2. High density polyethylene (HDPE) can be used where pH is 3 to 9. Do not use when pH is below 3 or above 9.

3. Were pH is 3 to 9, high molecular weight (Mn) and low carboxyl end group concentration (CEG) polyester products can be used. Do not use when pH is below 3 or above 9.

Table 1 – Embankment Geogrid		
Property	**Standard**	**MARV**

		Type 1	Type 2	Type 3
Ultimate strength, lb/ft	D6637	1500	4000	9000
Long term allowable design strength, lb/ft	(a)	450	1700	3600
Resistance to UV degradation, percent minimum	D4355	95	95	95
Resistance to long term degradation, percent minimum	EPA 9090	100	100	100

NOTES
(a) Long term allowable design strength is calculated by dividing the ultimate tensile strength by the product of the reduction factors for creep, installation damage and degradation for the design period. Values used for these reduction factors must be based on testing outlined by FHWA-NHI-09-087.

2.3 GEOGRID FOR ROADWAY SUBGRADE OR BASE COURSE

A. Base course geogrid (BCG) is used for gradations of aggregate where the median of the aggregate size (D50) is between 0.75-inches and 1.25- inches.

B. Large aggregate geogrid (LAG) is used where (D50) is greater than 1.25- inches.

C. Small aggregate geogrid (SAG) is used where (D50) is less than 0.75- inches.

Table 2 – Subgrade and Base Course Geogrid

Property	Standard	MARV					
		BCG		LAG		SAG	
Rib shape							
UV resistance at 500 hours, percent	D4355	70	70	70	70	70	70
Chemical resistance, percent	EPA 9090	100	100	100	100	100	100
Junction efficiency, percent	D7737	90	90	90	90	90	90
Ribs per junction	Observed	4	6	6	6	6	6
Aperture pitch, in.	Measured	1.0–1.3 (a)	1.6 (b)	2.4 (b)	2.4 (b)	1.3 (b)	1.3 (b)
Radial stiffness at 0.5% strain, lb/ft (c)	D6637	--	15,400	23,900	23,900	13,700	13,700
Isotropic stiffness ratio(d)	D6637	--	0.6	0.6	0.6	0.6	0.6
Torsional rigidity at 20 kg.cm, m-N/deg	GG9	6.5	--	--	--	--	--
Flexural rigidity (mg-cm)	D7748	750,000	--	--	--	--	--

Tensile strength at 2% strain (lb/ft)	D6637	400 x 600	--	--	--	--	--
Ultimate tensile strength (lb/ft)	D6637	1300 x 1900	--	--	--	--	--

NOTES

1. Machine and cross machine direction
2. Determined by measuring the spacing between sets of parallel ribs in any direction.
3. ASTM D6637 Method B with a 2-aperture gage length tested in all “rib” and “mid-rib” directions. The radial stiffness is computed as the minimum measured modulus at 0.5 percent strain for each direction.
4. Minimum measured radial stiffness at 0.5 percent strain divided by the maximum measured radial stiffness at 0.5 percent strain.

2.4 GEOGRID AND GEOCOMPOSITE FOR ROADWAY PAVEMENT

A. Placement is between bituminous pavement layers. Do not use with less than 2-inches of bituminous concrete cover.

B. Polyester geocomposite (PGC) is composed of a high modulus polyester geogrid bonded to a lightweight non-woven fabric.

C. Fiberglass geogrid (FG) is composed of a fiberglass geogrid coated with an elastomeric polymer.

D. Fiberglass geocomposite with a tack film (FGT) is composed of a fiberglass geogrid coated with an elastomeric polymer and bonded to a 100% polymer tack film.

Table 3 – Roadway Pavement Geogrids and Geocomposites

Property	Standard	MARV		
		PGC	FG	FGT
Opening size, in.	Measured	0.5-1.0	0.5-1.0	0.5-1.0
Ultimate tensile strength, lb/ft	D6637	3425 x 3425	6720 x 6720	6720 x 6720
Minimum tensile strength at 2% strain, lb/ft	D6637	--	4704 x 4704	4704 x 4704
Tensile strength at 3% strain, lb/ft	D6637	825 x 825	6720 x 6720	6720 x 6720
Melting point (geogrid), deg F	D276	490	430	430
Softening point (geotextile), deg F	–	220	--	--

Softening point (tack film), deg F	--	--	--	285
Adhesive Backing	--	--	Pressure Sensitive	Pressure Sensitive

2.5 CLAMPS, TAPE, RUBBER PADS

A. Recommended by Supplier.

2.6 TACK COAT

A. Recommended by geocomposite Supplier.

2.7 SOURCE QUALITY CONTROL

A. Sample geogrids and geocomposites using ASTM D4354 standard practices.

B. Verify specification conformance, ASTM D4759.

PART 3 – EXECUTION

3.1 PREPARATION

A. Instruct workers about protecting product of this Section.

B. Repair damage to subgrade surface before installation.

C. Round edges of excavation and grade changes.

3.2 GEOGRID REINFORCEMENT FOR GRANULAR BASE

A. Deploy each geogrid panel per manufacturer’s recommendations.

B. Install panels so overlapping panel is upgrade of the underlying panel. Ties or stakes can be used to maintain overlaps. Overlap as follows.

Soil	Recommended CBR Rating	Overlap
2 +	1.0 foot	
1 – 2	2.0 feet	
Less than 1	3.0 feet	

C. Do not bend or fold panels past 90 degrees without a minimum of 6 inches of material between bent or folded layers.

D. At least six (6) inches of fill cover is required if tracked vehicles are operated over geogrid.

E. Wheeled traffic may operate over polypropylene products if subgrade supports equipment without deforming. Repair any damage.

F. Verify geogrid installation by visual inspection for proper overlap, tension, and alignment.

3.3 GEOGRID REINFORCEMENT FOR ROADWAY PAVEMENTS

A. Preparation:

1. Clean surface of bituminous concrete base course.

2. Seal cracks wider than 1/8-inch, Section 32 01 17 “Sealing Cracks In Bituminous Paving”. Repair larger cracks, potholes, depressions, and irregularities.

3. Place bituminous concrete leveling course if required.

B. Spray on tack coat uniformly at 0.08 - 010 gal-yd^2.

C. Place geogrid per manufacture’s recommendations.

D. Overlap geogrid in a single fashion on tack coat in the direction of overlay placement. Overlap geogrid edges and ends six (6) inches minimum, unless required otherwise by Supplier.

3.4 SOIL REINFORCEMENT

A. Compact embankment subgrade.

B. Place geogrids or geocomposites in embankments at the locations and elevations shown on the plans or as recommended by Supplier.

C. Do not bend or fold panels past 90 degrees without a minimum of 6 inches of material between bent or folded layers.

D. Unless specified elsewhere, compact the fill to 95 percent or greater relative to a modified proctor density.

3.5 BACKFILL AND COMPACTION

A. Place and compact backfill material in lifts as specified in the project specifications or as recommended by the geogrid or geocomposite manufacturer.

B. Ensure that compaction equipment does not damage the geogrid or geocomposite during installation. Follow manufacturer's recommendations for equipment type and operation to prevent damage to the materials.

C. Maintain proper moisture content in the backfill material to ensure optimum compaction and performance of the geogrid or geocomposite.

3.6 FIELD QUALITY CONTROL

A. Inspect geogrid and geocomposite placement and overlaps for conformance with manufacturer's recommendations and project specifications.

B. Verify that backfill and compaction are being performed per project specifications and manufacturer's recommendations.

C. Monitor geogrid and geocomposite installation for damage or defects. Repair or replace damaged materials as needed.

3.7 CLEANUP AND PROTECTION

A. Remove debris, excess materials, and equipment from the installation area.

B. Protect installed geogrids and geocomposites from damage by subsequent construction activities. Repair or replace damaged materials as needed.

C. Cover and protect geogrids and geocomposites from direct sunlight and weather exposure as recommended by the manufacturer.

END OF SECTION

SECTION 31 11 00

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removal of trees, stumps, roots, and tree debris.
2. Clearing site of plant life, root systems and shrubs.
3. Removal of fences, fence posts, mailbox posts, and miscellany.
4. Safe disposal of removed items in accordance with local and federal regulations.
5. Protection of existing vegetation to remain.
6. Clearing and grubbing.

1.2 REFERENCES

A. NAA Standards:

1. Pruning Standards for Shade Trees.

B. Utah Shade Tree Pruning Standards.

C. Local and federal regulations for disposal of biological and non-biological waste.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on plans.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 QUALITY ASSURANCE

A. Provide at least one person, who is familiar with NAA pruning standards for the type of tree involved, to be present during tree pruning operations.

B. Employ certified arborist for the task to ensure the health of remaining trees.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 SITE CONDITIONS.

A. Document existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

B. Repair or replace damaged trees and shrubs at no additional cost to OWNER.

C. Survey and document the initial condition of the site including remaining trees, shrubs, and structures for reference purposes.

1.7 PROTECTION

A. Protect roots and branches of trees to remain.

B. Construct temporary barricading at tree's approximated drip line. Place continuous barricades at least three (3) feet high.

C. When setting posts, avoid damaging tree roots.

D. Do not permit heavy equipment or stockpiling of materials or debris within the barricaded area or permit earth surface to be changed.

E. Provide water and fertilizer to maintain existing trees.

F. Protect and maintain all marked historic or significant trees as per local regulations.

PART 2 - PRODUCTS

2.1 STUMP TREATMENT SOLUTION

A. Formulated to kill existing vegetation.

B. Provide stump treatment solution that is environmentally friendly and non-toxic to surrounding fauna and flora.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The drawings do not purport to show all trees and shrubs existing on site.

B. Verify with ENGINEER which plantings are to be removed or to remain.

C. Tree root inspection:

1. Assist ENGINEER by removing and replacing existing surface improvements.

2. Cost of removals and replacements will be paid for using existing payment prices, or if none, then by using contract Modification prices.

D. Record the condition and location of trees and shrubs to be preserved for future reference and care.

3.2 PREPARATION

A. Locate utilities. Preserve utilities that are to remain in service, Section 31 23 16 “Excavation.”

B. Review work procedures with ENGINEER.

C. Schedule work carefully with consideration for property owners and general public.

D. Before starting, arrange for disconnection of all utility services that are to be removed or which interfere with work.

E. Inform local authorities and utility companies if the work might affect public services or cause traffic disruption.

F. Protect and maintain benchmarks and survey control points from disturbance during construction.

G. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed.

3.3 SITE CLEARING

A. Remove all vegetation outside of excavation, fill slope lines, and limits of slope rounding to the limits shown on the plans.

B. Remove fences, posts, appurtenances, and miscellaneous objects.

C. Dispose of all waste material in accordance with local waste management guidelines and federal regulations.

D. Use only hand methods or air spade for grubbing within protection zones.

E. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.4 TREE REMOVAL

A. Remove branches, limbs, and debris.

B. Remove stumps and roots to 18 inches below exposed subgrade/grade.

C. For stumps larger than six (6) inches caliper remove and treat as follows:

1. Remove chips and debris from around remaining stump.

2. Apply stump treatment solution in accordance with manufacturer's recommendations.

3. Do not allow chemical solution to mist, drip, drift, or splash onto adjacent ground surfaces or desirable vegetation.

4. Replace any existing vegetation damaged or killed through improper use of chemical at no additional cost to OWNER.

D. Provide immediate care for remaining trees that may be distressed due to the removal process.

E. For stumps larger than six (6) inches caliper, grind down to level with surrounding ground and replace with topsoil to encourage natural decay.

F. For stump treatment solution: ensure it does not contaminate surrounding soil, water sources, or affect local wildlife.

G. Chip removed tree branches and dispose of off-site.

3.5 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off OWNER’s property.

B. Burning tree, shrub, and other vegetation waste is permitted according to burning requirements and permitting of authorities having jurisdiction. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 31 23 16

EXCAVATION

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavation and disposal of excavated materials.
2. Protection of existing facilities such as utilities, vegetation, structures affected by excavation, etc.
3. Soil testing and analysis for proper backfill selection and compaction.
4. Vibration monitoring and mitigation during excavation activities.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Not Applicable.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. Authorized Over Excavation: Upper limit of excavation is proposed excavation limit. Lower and lateral limits are as authorized by ENGINEER.

B. Classified Excavation: The excavation of specified materials.

C. Incidental Excavation: Also referred to as unauthorized excavation. Excavation done for CONTRACTOR's benefit, excavation error, dewatering of excavation, slough, or over-break.

D. Unclassified Excavation: The excavation of all materials encountered regardless of the nature, size, or manner in which they are removed. Presence of isolated boulders or rock fragments will not be sufficient cause to change classification of surrounding materials.

E. Keyholing: The process of making a small, precisely controlled hole for "day-lighting", or uncovering and exposing underground utilities, in order to locate or inspect them.

F. Vibration Monitoring: The process of measuring and analyzing ground vibrations generated by excavation activities to prevent damage to nearby structures and utilities.

1.7 STORAGE AND HANDLING

A. Stockpile excavated material to cause minimum inconvenience to public and provide for emergency services as necessary.

B. Provide free access to existing fire hydrants, water valves, gas valves, and meters.

C. Provide free flow of storm water in all gutters, conduits, and natural water courses.

D. Utilize traffic control signs, markers, and procedures in product storage and handling activities.

E. Promptly remove other material from site and legally dispose of them off OWNER's property, Section 31 11 00 "Site Clearing".

PART 2 – PRODUCTS

2.1 BACKFILL MATERIALS

A. Common fill, Section 31 05 13 "Common Fill."

B. Aggregate base course, Section 32 11 23 "Aggregate Base Courses."

C. Stabilization fill, aggregate base course or common fill with maximum rectilinear particle size of two (2) inches.

D. Stabilization fabric, Section 31 05 19 "Geotextiles."

E. Controlled low-strength material (CLSM), also known as flowable fill, for filling voids and abandoned underground structures, Section 31 05 15 "Cement Treated Fill."

F. Geofoam, a lightweight fill material for reducing loads on underlying soils or structures.

PART 3 – EXECUTION

3.1 PREPARATION

A. Photograph existing surfaces where work will take place to document conditions before excavation, Section 01 78 39 "Project Record Documents."

B. Use white paint and mark the proposed excavation.

C. Call the one-call center and wait the required amount of time. Colors of one call center marks indicate the following:

White	Proposed excavation

Red	Electric power lines, cables, conduit and lighting cables
Yellow	Gas, oil, steam, petroleum or gaseous materials
Orange	Communications, alarm, signal, cables or conduits
Blue	Potable water
Purple	Reclaimed water, irrigation and slurry lines
Green	Sewer and storm drain lines
Pink	Temporary survey markings

D. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.”

E. For temporary controls, refer to Section 01 57 00 “Temporary Controls.” For site clearing, refer to Section 31 11 00 “Site Clearing.” Do not commence earth-moving operations until temporary site fencing, erosion and sediment control measures are in place.

F. Conduct soil testing and analysis to determine the appropriate backfill materials and compaction requirements.

3.2 PROTECTION

A. Identify required lines, grades, contours, and benchmarks, Section 01 71 23 “Field Engineering.”

B. Utilities:

1. Keyhole, expose or otherwise locate utilities as necessary to give utility agency at least one (1) day notice to protect, preserve, or relocate a utility that may interfere with or may be damaged by excavation work. Preserve utilities that remain in service.

2. No Contract Time extension will be granted, and no additional compensation will be made if buried utilities or structures that conflict with the Work have not been found by Keyholing.

3. Where utilities or structures conflict with design grades, report conflict to appropriate utility company and ENGINEER 14 days before initiating work within the conflict area.

C. Support and protect from damage any existing facility and structure that exists in, passes through, or passes under the site.

D. Protect existing landscape sprinkler systems. When sprinkler system disturbance is required, interrupt and repair system so operation of system is maintained, Section 02 41 13 “Selective Site Demolition.”

E. Implement vibration monitoring and mitigation measures during excavation activities to protect nearby structures and utilities from damage.

F. Carefully remove soil around tree roots so ENGINEER can assess stability and health of tree.

3.3 GENERAL EXCAVATION REQUIREMENTS

A. Earth excavation includes excavating obstructions visible on the surface that are not covered under a bid item, including but not limited to shrubs, trees, and vegetation; underground structures, utilities, and other items indicated to be removed, and other materials not classified as rock or unauthorized excavation.

B. Excavate topsoil from areas to be relandscaped or regraded and other marked areas.

C. Excavate site to line and grade indicated. Legally dispose of excavated material.

D. Carefully excavate soils in vicinity of buried utility marks placed by the one-call center.

E. Where soil has been softened or eroded by flooding or hardened by drying, rework all damaged areas or replace with approved material at no additional cost to OWNER.

F. Monitor air quality during excavation activities to ensure compliance with applicable regulations and minimize impacts on workers and the surrounding community.

G. Notify ENGINEER of unexpected subsurface conditions.

H. Underpin adjacent structure, service utilities and pipe chases that may be damaged by excavation work.

I. Protect excavation walls as required. If conditions permit, slope excavation sides to maintain a safe and clean working area. Remove loose materials.

J. Where ENGINEER deems subgrade material to be susceptible to frost heave or otherwise unsatisfactory, excavate additional depth.

3.4 TOPSOIL

A. Excavate topsoil only to depth that will preserve topsoil quality.

B. Do not mix topsoil with subsoil during stockpiling or spreading.

C. Salvage and store topsoil for later reuse in landscaping or site restoration, as necessary.

3.5 SHORING

A. Slope, shore, sheet, brace or otherwise support excavations over four (4) feet deep, Section 31 41 00 “Shoring.”

B. When soil conditions are unstable, excavations shallower than four (4) feet deep must also be sloped, supported or shored.

C. Employ the use of trench boxes or other approved protective systems in deep or unstable trenches to ensure worker safety.

3.6 DEWATERING

A. For dewatering plan requirements see Section 31 23 19 “Dewatering.”

3.7 ROADWAY EXCAVATION

A. In advance of setting line and grade stakes, clear and grub area of brush, weeds, vegetation, grass, and debris. Drain all depressions or ruts.

B. Roadway excavation is Unclassified Excavation. It includes Portland cement concrete or bituminous concrete pavement removal and removal of any aggregate base or sub-base material to line and grade established by Drawings or ENGINEER.

C. Coordinate with local authorities to obtain necessary permits and approvals for roadway excavation and traffic detours.

D. Notify ENGINEER when excavations have reached required subgrade.

E. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by ENGINEER , and replace with compacted backfill or fill as directed. See Authorized Over Excavation.

3.8 STRUCTURAL AND LANDSCAPE EXCAVATION

A. Provide shoring, cribs, cofferdams, caissons, pumping, bailing, draining, sheathing, bracing, and related items.

B. For piling work, coordinate special requirements for piling. Protect excavation walls.

C. If conditions permit, slope excavation sides as excavation progress. Maintain a safe and clean working area.

D. Support excavations. Do not interfere with the bearing of adjacent foundations, pipelines, etc.

E. Excavate and remove unsuitable materials (e.g., organic material, debris, or soft soils) beneath structural and landscape elements and replace with suitable backfill materials.

F. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.9 TRENCH EXCAVATION

A. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: As indicated.

B. If necessary, make bell holes and depressions required for laying and joining pipe or box.

C. Limit width of trench excavations to the dimensions suitable for worker access per pipe manufacturer's recommendation. Provide enough space for compaction equipment. Notify ENGINEER if excavation operations exceed any indicated line and grade limits.

D. In roadways and regardless of trench depth, limit length of open trenches to 200 lineal feet day or night. Provide barricading, Section 01 55 26 “Traffic Control.” Protect trenches overnight.

E. Backfill trenches with approved materials in lifts, compacting each lift to achieve the specified compaction requirements.

3.10 STABILIZATION EXCAVATION

A. Perform stabilization excavation as Incidental Excavation.

B. Implement erosion and sediment control measures during stabilization excavation to minimize sediment runoff and comply with stormwater management regulations.

3.11 AUTHORIZED OVER EXCAVATION

A. Over excavation must be permitted by ENGINEER to be classified as authorized over excavation. Volume will be determined by the method of average-end-areas in the original position.

3.12 TOLERANCE

A. Grading: Top surface of Subgrade = plus or minus 1 inch.

3.13 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

   1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

END OF SECTION

SECTION 31 23 17

ROCK REMOVAL

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for rock removal and use of explosives to assist in rock removal.
2. Use of non-explosive rock removal methods, such as hydraulic breakers and rock splitting equipment.
3. Coordination with local authorities and stakeholders for safe and compliant rock removal operations.

1.2 REFERENCES

A. NFPA Standards:

1. 495 Manufacture, Transportation, Storage, and Use of Explosive Materials.

B. OSHA Standards:

1. 29 CFR 1926.900 - Blasting and Use of Explosives.

1.3 SUBMITTALS

A. Submit proposed method of blasting, delay pattern, explosive types, type of blasting mat cover, and intended rock recovery method.

B. Submit photographs of existing site conditions and facilities in vicinity of Work before blasting. Refer to construction photographic requirements, Section 01 78 39 “Project Record Documents.”

1.4 QUALITY ASSURANCE

A. Seismic Survey Firm: Company specializing in seismic surveys with two (2) years documented experience.

B. Explosive Firm: Company specializing in explosives for disintegration of rock with 2 years documented experience.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

B. Rock: Solid mineral material in beds and/or ledges that exceed 1 cubic yard for bulk excavation or 3/4 cubic yard for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting when permitted:

1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator, equipped with a 42-inch-maximum width, short-tip-radius rock bucket, rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.

2. Equipment for Bulk Excavation: Late-model, track-mounted loader, rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.

C. Non-Explosive Rock Removal Methods: Techniques and equipment used for rock removal without the use of explosives, such as hydraulic breakers, rock splitters, or mechanical excavation.

1.7 SAFETY REQUIREMENTS

A. Comply with OSHA regulations and local laws related to rock removal operations, including but not limited to drilling, blasting, and handling of explosives.

B. Provide appropriate personal protective equipment (PPE) for workers engaged in rock removal operations.

C. Develop and implement a site-specific safety plan for rock removal operations, including emergency response procedures.

PART 2 – PRODUCTS

2.1 EXPLOSIVES

A. Type recommended by explosives firm following seismic survey and required by authorities having jurisdiction.

2.2 DELAY DEVICES

A. Type recommended by explosives firm.

2.3 BLASTING MAT MATERIALS

A. Type recommended by explosives firm.

2.4 NON-EXPLOSIVE ROCK REMOVAL EQUIPMENT

A. Hydraulic Breakers: Heavy-duty equipment designed to break rock using high-impact forces.

B. Rock Splitters: Equipment that uses hydraulic pressure to create controlled cracks in rock for easier removal.

PART 3 – EXECUTION

3.1 PREPARATION

A. Verify site conditions and note irregularities affecting work of this Section.

B. Obtain permits from authorities having jurisdiction before explosives are brought to site or drilling is started.

C. Locate and preserve utilities, Section 31 23 16 “Compaction.”

D. Beginning work of this Section constitutes acceptance of existing conditions.

E. Comply with NFPA 495.

F. Notify all affected parties, including adjacent property owners, utility companies, and local authorities, of the scheduled rock removal operations.

G. Coordinate with local authorities to obtain necessary permits, approvals, and road closures, if required.

H. Establish and maintain communication with local emergency services during rock removal operations.

I. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

1. 24 inches outside of concrete forms other than at footings.

2. 12 inches outside of concrete forms at footings.

3. 6 inches outside of minimum required dimensions of concrete cast against grade.

4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.

5. 6 inches beneath bottom of concrete slabs-on-grade.

6. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

3.2 STORAGE OF BLASTING MATERIALS

A. Securely store all explosives in compliance with Laws and Regulations.

B. Mark all storage places clearly.

C. Where no local Laws or Regulations apply, provide storage not closer than 1,000 feet from any road, building, camping area or place of human occupancy.

3.3 ROCK REMOVAL - NONEXPLOSIVE METHOD

A. Cut away rock at excavation bottom to form level bearing.

B. Remove shaled layers to provide sound and unshattered base for foundations.

C. Remove and legally dispose of excess excavated material and debris off-site unless indicated otherwise.

D. Correct unauthorized rock removal at no additional cost to OWNER.

E. Use non-explosive rock removal methods, such as hydraulic breakers or rock splitters, where the use of explosives is restricted, impractical, or poses a risk to adjacent structures or utilities.

F. Implement dust control measures, such as water spraying, to minimize air pollution during non-explosive rock removal operations.

G. Minimize noise and vibration impacts on the surrounding environment and communities by selecting appropriate equipment and scheduling work during permitted hours.

3.4 ROCK REMOVAL - EXPLOSIVE METHOD

A. Provide a qualified explosives expert to act as an advisor and consultant during drilling and blasting operations.

B. Advise owners of adjacent buildings or structures and utility companies in writing before setting up seismographs. Describe blasting and seismic operations.

C. Establish a safety perimeter around the blasting area to prevent unauthorized access and ensure the safety of workers and the public.

D. Conduct post-blast inspections to verify the extent of rock removal, identify any remaining rock hazards, and assess the condition of adjacent structures and utilities.

E. Implement dust and noise control measures during blasting operations, such as using blasting mats or scheduling blasts during permitted hours, to minimize impacts on the surrounding environment and communities.

F. Properly dispose of used blasting materials and debris in compliance with environmental regulations and guidelines.

G. Obtain and pay for a seismic survey before rock excavation to determine maximum charges that can be used at different locations in area of excavation without damaging adjacent properties and utilities.

H. Provide seismograph monitoring during progress of blasting operations.

I. Disintegrate and remove rock from excavation operations.

END OF SECTION

SECTION 31 23 19

DEWATERING

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Construction dewatering.

1.2 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUBMITTALS

A. Dewatering Plan: Submit a detailed dewatering plan prepared by a licensed civil engineer, registered in the State of Utah, for approval by the OWNER's authorized representative prior to the commencement of dewatering activities. The plan shall include:

1. The proposed dewatering system layout and equipment.
2. Calculations supporting the design of the dewatering system.
3. The anticipated dewatering schedule.
4. Procedures for monitoring the performance of the dewatering system, groundwater levels, and potential impacts on adjacent structures, utilities, and pavement.
5. Measures for mitigating adverse effects of dewatering operations, including settlement, rebound, and removal of fine materials from the subgrade.
6. The proposed method for treating, filtering, and desilting dewatering water.
7. Details of the sedimentation tanks, sumps, and other flow-control devices as required by authorities having jurisdiction.

B. Permits: Submit a copy of the General Permit for Construction Dewatering issued by the Utah Division of Water Quality, along with the approved discharge plan, prior to beginning any dewatering activities and discharge of recovered water.

C. Monitoring Reports: Submit periodic monitoring reports documenting the performance of the dewatering system, groundwater levels, and any observed impacts on adjacent structures, utilities, and pavement. Include a summary of any necessary corrective actions taken.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. OWNER is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.

2. The geotechnical report is included elsewhere in Project Manual.

1.7 MAINTENANCE

A. Maintain dewatering system to ensure proper operation and performance throughout the duration of the construction period. Perform periodic inspections, maintenance, and repairs as needed.

B. Remove sediment, debris, and any obstructions from sumps, sedimentation tanks, and flow-control devices as required to maintain proper operation.

C. Maintain backup equipment and standby units for dewatering pumps, treatment systems, and power sources to ensure continuous operation in case of equipment failure or breakdown.

1.8 DEWATERING SYSTEM REMOVAL

A. Upon completion of dewatering operations and backfilling, remove the dewatering system, including wells, well points, pumps, piping, sedimentation tanks, and flow-control devices.

B. Restore the site to its original condition, including any grading, landscaping, or pavement that was affected by the dewatering system installation and removal.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

2.2 DEWATERING EQUIPMENT AND MATERIALS

A. Dewatering Pumps: Provide self-priming, centrifugal, or submersible pumps, with sufficient capacity and head to handle the anticipated flow rates and dewatering requirements. Include automatic level controls and alarms to maintain water levels within specified limits.

B. Backup Pumps: Provide a minimum of one backup pump per primary pump, with similar capacity and performance characteristics, available for immediate use in case of primary pump failure or breakdown.

C. Standby Power Source: Provide a standby generator, sized to power all dewatering pumps and related equipment, in case of power loss or outage.

D. Piping and Hoses: Provide pipes and hoses of sufficient diameter and pressure rating to handle the anticipated flow rates, with appropriate fittings, valves, and appurtenances for the dewatering system.

E. Filter Material: Provide filter fabric or other approved filtering materials compatible with the dewatering system and capable of removing suspended solids from the discharged water.

F. Water Treatment System: Provide a water treatment system that effectively removes sediment, suspended solids, and contaminants from the dewatered water as required by governing authorities and discharge permits. Include redundant and standby units to safeguard against breakthrough of the primary treatment units.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 01 57 00 "Temporary Controls," during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

3.3 OPERATION

A. CONTRACTOR shall provide an adequate dewatering system for the control of surface, ground, and stormwater in trench and structure excavations and elsewhere on the project as necessary during the construction period. Excavations shall be kept and stable dry during construction operations. The water table shall be kept at least one foot below the bottom of the excavation until backfill has been completed.

B. The CONTRACTOR shall provide a satisfactory means for desilting and treating dewatering water, approved by the Utah Division of Water Quality, before discharging it to the storm system, where necessary. Groundwater pumped out during any dewatering process shall be desilted and filtered to separate out suspended solids. The supernatant shall also be treated where required prior to discharge. The desilting, filtering, and treatment system shall have redundancy and standby units to safeguard against breakthrough of the primary units. The CONTRACTOR shall apply for a permit to discharge groundwater recovered from the excavation. This General Permit for Construction Dewatering is issued by:

Utah Division of Water Quality
288 North 1460 West
P.O. Box 144870
Salt Lake City UT 84114-4870
Permit Administrator: Harry Campbell
801-536-4391

C. The CONTRACTOR shall be responsible for meeting all provisions set forth in the permit, including collecting water samples from the point of discharge, following the sampling schedule and chemical analyses specified by the Division of Water Quality in the General Permit for Construction Dewatering. In addition to the provisions set forth in the discharge permit, the CONTRACTOR shall submit a copy of the General Permit for Construction Dewatering and discharge plan for approval by the OWNER’s authorized representative prior to beginning any dewatering activities and discharge of recovered water.

D. Except for temporary shutdowns for maintenance of dewatering equipment, no interruptions in the dewatering system procedures shall be permitted until backfilling is completed in accordance with Contract Documents. The CONTRACTOR shall be available 24 hours a day, as needed, to maintain dewatering operations.

E. The extent and depth of dewatering shall be controlled to avoid impacts to existing and proposed facilities, including consolidation settlement, rebound, and removal of fine materials from the subgrade. The CONTRACTOR shall be solely responsible for mitigating and repairing any damage from dewatering operations to existing above grade and below grade structures, utilities, and pavement. In the event of movement or settlement, the CONTRACTOR shall then modify its operations and implement mitigation measures to stop the movement. The Control of deformation in structures potentially affected by dewatering operations shall be addressed in the CONTRACTOR's dewatering plan. Any structures, utilities, and pavement damaged by dewatering operations shall be repaired or replaced at no cost to the OWNER.

F. The project geotechnical investigations are available from the OWNER. The OWNER is making the information available as a convenience only and is in no way guaranteeing the accuracy or completeness of such data, and any conclusions drawn from inspection thereof shall be the CONTRACTOR's responsibility and subject to whatever measures the CONTRACTOR deems necessary for verification of the data contained therein. The CONTRACTOR shall not be relieved of liability under the contract for any loss sustained as a result of any variance between conditions indicated by or deduced from said reports, letters and logs of borings and the actual conditions encountered during the progress of work.

3.4 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages to adjacent facilities caused by dewatering. Pay for damages and costs resulting from dewatering operations.

C. Slope Stabilization and shoring Investigate and provide materials, means and methods for providing safe cut slopes for construction. This may include dewatering, shoring, sheet piling, or other mechanical methods of stabilization of slopes as determined by the CONTRACTOR, and in accordance with Section 31 41 00 "Shoring." All work shall be approved by the OWNER's authorized representative prior to implementation. Shoring and slope stabilization, as needed and determined by the CONTRACTOR, shall be designed by a licensed civil engineer registered in the State of Utah and must be in conformance to federal, state, and local rules and regulations.

3.5 MONITORING AND REPORTING

A. Monitor the performance of the dewatering system, groundwater levels, and potential impacts on adjacent structures, utilities, and pavement in accordance with the approved dewatering plan.

B. Prepare and submit periodic monitoring reports as required by the OWNER's authorized representative and in compliance with permit requirements. Include a summary of any necessary corrective actions taken and their effectiveness.

C. Notify the OWNER's authorized representative immediately in case of dewatering system failure, excessive settlement, or any adverse effects on adjacent facilities or the environment. Implement corrective actions as needed to mitigate and resolve the issue.

3.6 DISPOSAL OF DEWATERED WATER

A. Dispose of dewatered water in accordance with the approved discharge plan, permit requirements, and applicable regulations. Ensure that the discharge location is suitable for the volume and flow rate of the dewatered water.

B. In areas where dewatering discharge may cause erosion, provide appropriate erosion control measures, such as riprap or energy dissipators, to minimize erosion and sediment transport.

C. Ensure that the dewatered water is treated and filtered to meet the water quality requirements specified by the Utah Division of Water Quality and any other applicable regulatory agencies.

END OF SECTION

SECTION 31 23 23

BACKFILLING FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural backfill materials.
2. Structural backfilling requirements.
3. Soil compaction and testing methods.
4. Environmental protection and erosion control measures.

1.2 REFERENCES

A. ASTM Standards:

1. D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
2. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft- lbf/ft3 (2,700 kN-m/m3)).
3. D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
4. D4832 Preparation and Testing of Soil-Cement Slurry Test Cylinders.
5. D4253 Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
6. D4254 Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

1.3 SUBMITTALS

A. Submit maximum laboratory dry density and optimum laboratory moisture content for:

1. Subgrade material, and
2. Each type of fill to be used.

1.4 QUALITY ASSURANCE

A. Do not change material sources or aggregate without ENGINEER's knowledge.
B. Reject backfill material that does not comply with requirements specified in this Section.

C. If requested, submit a written quality control inspections and testing report describing source and field quality control activities performed by CONTRACTOR and Suppliers.

1.5 ACCEPTANCE

A. General: Native material may be wasted if there is no additional cost to substitute material acceptable to ENGINEER.
B. Material: For material acceptance refer to:

1. Common fill, Section 31 05 13.

2. Aggregate base course, Section 32 11 23.

3. Cement treated fill, Section 31 05 15.

C. Lift thickness: One test per Lot.

D. Compaction: One test per Lot. Verify compaction using nuclear tests, ASTM D2922. Density and lot sizes as follows:

Table 1 – Density and Lot Sizes

Structure Type	Density	Proctor	Lot Size
Strip Footings	95	Standard	Subgrade: 200 linear feet
	98	Modified	Aggregate base course: 200 linear feet per lift.
Structure Footing excluding strip footings	95	Standard	Subgrade: 225 square feet.
	98	Modified	Aggregate base course: Each 225 square feet per lift
Embankments	95	Standard	Fill: 625 square feet per lift
Interior Slab on Grade	98	Modified	Aggregate base course: 625 square feet
Side of Foundation Walls and Retaining Walls	95	Standard	Exterior:
	98	Modified	Interior
Miscellaneous small structures (e.g. Manholes, drainage boxes, etc.)	95	Standard	Subgrade: Each footprint area Fill: Each lift
	98	Modified	Aggregate base course: Each lift

NOTES

1. Standard proctor, ASTM D698.

2. Modified proctor, ASTM D1557.

E. Flowable Fill Strength: Lot size is one day production with sub-lots of 250 cubic yards or part thereof. Verify strength using cylinders, ASTM D4832.

F. Grade, Cross Slope: Measured at random locations.

1.6 STORAGE

A. Safely stockpile backfill materials.

B. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.

1.7 SITE CONDITIONS

A. Do not place, spread, or roll any backfill material over material that is damaged by water. Remove and replace damaged material at no additional cost to OWNER.

B. Control erosion. Keep area free of trash and debris. Repair settled, eroded, and rutted areas.

C. Reshape and compact damaged structural section to required density.

1.8 WARRANTY

A. Repair settlement damage at no additional cost to OWNER.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Comply with applicable local, state, and federal regulations related to erosion control and stormwater management during backfilling operations.

B. Implement sediment and erosion control measures to prevent soil erosion and sedimentation of water bodies, as required by the applicable regulations.

PART 2 - PRODUCTS

2.1 BACKFILL MATERIALS

A. Common fill, Section 31 05 13. Granular material, CONTRACTOR’s choice.

B. Aggregate base course, Section 32 11 23. Untreated base course.

C. Cement treated fill, Section 31 05 15. Use a flowable fill so vibration is not required.

2.2 WATER

A. Make arrangements for sources of water during construction and make arrangements for delivery of water to site.

B. Comply with local Laws and Regulations at no additional cost to OWNER when securing water from water utility company.

2.3 GEOTEXTILES AND GEOGRIDS

A. Geotextiles: Non-woven, needle-punched, or woven materials used to separate, reinforce, or stabilize soil layers.

B. Geogrids: High-strength, polymeric materials used for reinforcement, stabilization, or confinement of soil layers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.”

B. Verify:

1. Backfill material meets gradation requirements.

2. Foundation walls are braced to support surcharge forces imposed by backfilling operations, areas to be backfilled are free of debris, snow, ice or water.

3. Ground surface is not frozen.

C. If ground water is in the intended backfill zone, dewater.

3.2 PROTECTION

A. Protect existing trees, shrubs, lawns, structures, fences, roads, sidewalks, paving’s, curb and gutter and other features.

B. Protect above or below grade utilities. Contact utility companies to repair utility damage. Pay all cost of repairs.

C. Avoid displacement of and damage to existing installations while compacting or operating equipment. Do not fill adjacent to structures until excavation is checked by ENGINEER.

D. Do not use compaction equipment adjacent to walls or retaining walls that may cause wall to become over-stressed or moved from alignment.

E. Do not disturb or damage foundation perimeter drainage, foundation, damp-proofing, foundation waterproofing and protective cover, or utilities in trenches. Movement of construction machinery over work at any stage of construction is solely at CONTRACTOR's risk.

F. Restore any damaged structure to its original strength and condition.

3.3 LAYOUT

A. Identify required line, levels, contours, and datum.

B. Stake and flag locations of underground utilities.

C. Upon discovery of unknown utility or concealed conditions, notify ENGINEER.

D. Maintain all benchmarks, control monuments and stakes, whether newly established by surveyor or previously existing. Protect from damage and dislocation.

E. If discrepancy is found between Contract Documents and site, ENGINEER shall make such minor adjustments in the Work as necessary to accomplish the intent of Contract Documents without increasing the Cost of the Work to CONTRACTOR or OWNER.

3.4 SUBGRADE

A. Protect Subgrade from desiccation, flooding, and freezing.

B. Before backfilling over Subgrade, get ENGINEER's inspection of subgrade surface preparations.

C. If Subgrade is not readily compactable get ENGINEER’s permission to stabilize the subgrade.

3.5 FOUNDATIONS AND SLABS ON GRADE

A. Lift thickness before compaction is eight (8) inches.

B. Do not backfill against walls until concrete has obtained 14 days strength. Backfill against foundation walls simultaneously on each side.

C. Fill unauthorized excavations with material acceptable to ENGINEER at no additional cost to OWNER.

D. Do not damage adjacent structures or service lines.

E. Where flowable fill is used, use fill that flows easily and vibration for compaction is not required.

3.6 MODIFIED BACKFILL LAYER METHOD

A. Section 33 05 20 “Backfilling Trenches.”

3.7 TOLERANCES

A. Compaction: Ninety-five (95) percent or ninety-eight (98) percent minimum relative to a standard or modified proctor density, Section 31 23 26 “Compaction.”

B. Lift Thickness (before compaction):

1. Eight (8) inches when using riding compaction equipment.

2. Six (6) inches when using handheld compaction equipment.

3. As proven in the modified backfill layer method, Section 33 05 20 “Backfilling Trenches.”

C. Cement Treated Fill: Compressive strength targets are 60 psi in 28 days and 90 psi maximum in 28 days.

3.8 CLEANING

A. Remove stockpiles from site. Grade site surface to prevent free standing surface water.

B. Leave borrow areas clean and neat.

3.9 GEOTEXTILES AND GEOGRIDS INSTALLATION

A. A. Install geotextiles and geogrids in accordance with the manufacturer's recommendations and the requirements specified in the design documents.

B. Overlap geotextile edges a minimum of 12 inches (300 mm) or as recommended by the manufacturer.

C. Secure geogrids to prevent movement during backfilling operations.

3.10 SOIL COMPACTION AND TESTING

A. Compact backfill materials to achieve the required density and moisture content specified in the design documents and applicable standards.

B. Use appropriate compaction equipment for the type of soil, lift thickness, and specified compaction requirements.

C. Perform compaction tests at the frequency specified in the design documents, and provide test results to the ENGINEER for review and approval.

3.11 EROSION CONTROL MEASURES

A. Install erosion control measures, such as silt fences, sediment basins, or erosion control blankets, as required by the applicable regulations and design documents.

B. Inspect and maintain erosion control measures regularly and after significant storm events. Replace or repair damaged or ineffective measures promptly.

C. Remove temporary erosion control measures once the site is stabilized and permanent vegetation or other stabilization measures are established.

3.12 FINAL GRADING AND CLEANUP

A. Perform final grading to ensure positive drainage away from structures and to prevent ponding of water.

B. Stabilize disturbed areas with vegetation, mulch, or other approved methods to prevent soil erosion.

C. Remove excess or unsuitable backfill materials, debris, and equipment from the site upon completion of backfilling operations.

END OF SECTION

SECTION 31 23 26

COMPACTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Compaction of granular fill materials.

1.2 REFERENCES

A. ASTM Standards:

1. D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

2. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft- lbf/ft3 (2,700 kN-m/m3)).

3. D2216 Laboratory Determination of Water (Moisture) Content of Soil and Rock.

4. D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

5. D3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

6. D3282 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

7. D3740 Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

8. D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.3 SUBMITTALS

A. Not Applicable.

1.4 QUALITY ASSURANCE

A. Use a soil and rock laboratory that complies with ASTM D3740.

B. Ensure all testing personnel are trained and certified to perform the specified tests.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. A-1 Soil: Defined in ASTM D3282.

B. Modified Proctor Density: The maximum laboratory density, as defined in and determined by ASTM D1557 using procedure A, B or C as applicable.

C. Relative Density (or Relative Compaction): The ratio of field dry density to the maximum laboratory density expressed as a percentage.

D. Standard Proctor Density: The maximum laboratory density, as defined in and determined by ASTM D698 using procedure A, B or C as applicable.

E. Optimum Moisture Content (OMC): The moisture content at which the soil reaches its maximum dry density under a specified compactive effort.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 COMPACTION

A. Moisten or dewater backfill material to achieve a moisture content within 2% of the optimum level for compaction.

B. When no density compactive effort is specified, compact the entire area to 95 percent and eliminate unstable zones.

C. Correct deficient compaction conditions. Replace or repair materials and damaged facilities.

D. Compact materials in lifts not exceeding 8 inches (200 mm) in loose thickness for cohesive soils and 12 inches (300 mm) for granular soils. For materials compacted by hand-operated tampers, use lifts not exceeding 4 inches (100 mm) in loose thickness. Adjust lift thickness based on the capability of the compaction equipment used.

3.2 FIELD QUALITY CONTROL

A. Testing: Perform control testing of materials in conformance with the latest edition of A's Construction Quality Procedures. Perform additional testing at no additional cost to OWNER, for

1. Changes in source of materials or proportions requested by CONTRACTOR, or

2. Failure of materials to meet specification requirements, or

3. Other testing services needed or required by CONTRACTOR.

B. Optimum Soil Density: Use ASTM D2216 and the following industry standards.

1. For A-1 Soils: Method C of ASTM D1557 (Modified Proctor).

2. For All Other Soils: Method C of ASTM D698 (Standard Proctor).

C. Field Density:

1. Use ASTM D3017 and test method C of ASTM D2922 for shallow depth nuclear testing.

2. No density determinations are required on any material containing more than 65 percent material retained on the number 10 sieve or more than 60 percent material retained on the number 4 sieve. In lieu of reporting densities in such cases, report the sieve analysis to document the material type.

3.3 REPORT

A. For each material tested, document the following:

1. Vertical and horizontal location of the test.

2. Optimum laboratory moisture content.

3. Field moisture content.

4. Maximum laboratory dry density.

5. Field density.

6. Percent compaction results.

7. Certification of test results by Independent Testing Agency.

8. Include any corrective actions taken in case of failed tests, along with retest results.

END OF SECTION

SECTION 31 25 00

EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Erosion control and slope protection facilities including blankets or mulches.
2. Construction of drainage facilities to protect work area.
3. Sediment control measures including silt fences, sediment basins, and sediment traps.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Submit before using:

1. Sample of blanket or geotextile materials.
2. Mulch formula.
3. Grass mixture listing.
4. Plant list.
5. Geotextile manufacturer's certification.

B. Application rate of fiber mulches recommended by tackifier manufacturer.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver seed in original containers with certified germination test results showing analysis of seed mixture, percentage of pure seed, year of production, and date of packaging. Damaged packages are not acceptable. Store seed free of moisture.

B. Deliver fertilizer in waterproof bags showing weight, chemical composition, and name of manufacturer.

C. Deliver blanket in original wrapping showing name of manufacturer and product weight.

D. Deliver plant materials immediately before placement.

E. Replace plant when original root protection system (burlap bag wrap of earth ball, plastic container with special plant bedder, etc.) has been broken or displaced before planting.

F. Store and handle materials in accordance with manufacturer's recommendations to prevent damage, deterioration, or loss.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Riprap: Rock, Section 31 37 00 “Riprap or Rock Lining.”

B. Blankets: Uniform open weave jute, wood fiber, biodegradable or photodegradable synthetic fiber matting.

C. Geotextiles: Section 31 05 19 “Geotextiles.”

D. Erosion Control Vegetation Mats: Permanent three-dimensional mats that allow for revegetation where high water flows are expected.

E. Fiber Mulches: Straw, hay, wood, or paper free from weeds and foreign matter detrimental to plant life.

F. Mulch Binder: Vegetable based gel tackifier with growth stimulant.

G. Topsoil and Fertilizer: Section 31 05 13 “Common Fill” and Section 32 92 00 “Turf and Grass.”

PART 3 – EXECUTION

3.1 PREPARATION

A. Remove foreign materials, roots, rocks, debris.

B. Grade to eliminate rough spots, ponding areas.

C. Grade soil to drain perimeter water away from protected areas.

D. Temporary controls, Section 01 57 00 “Temporary Controls” as applicable. Install all erosion and sediment control measures as specified in the approved ESCP before commencing any construction activities.

3.2 SLOPE PROTECTION BLANKET

A. Cover seeded slopes where grade is greater than one (1) vertical to three (3) horizontal with blanket. Roll down over slopes carefully and loosely without stretching or pulling.

B. Lay blanket smoothly on prepared soil surface. Bury top end of each section in a narrow trench. Leave 24 inches overlap from top roll over bottom roll. Leave 12 inches overlap over adjacent section.

C. Toe-wrap fabric at bottom of slope.

D. Staple loosely the outside edges and overlaps.

E. In ditches, lay matting in upstream direction. Overlap and staple ends six (6) inches with upstream section on top.

F. If natural drainage water traverses protected or controlled area; construct a channel or riprap Section 31 37 00 “Riprap or Rock Lining.”

G. Lightly dress slopes with topsoil to ensure close contact between cover and soil.

H. Present alternative methods of protection for approval before starting any work.

I. Secure blanket edges and overlaps with appropriate stakes or pins, spaced as per manufacturer's recommendations.

3.3 GEOTEXTILE

A. Placement, Section 31 05 19 “Geotextiles.”

B. Ensure proper overlap and connection of geotextile sections to maintain continuity and effectiveness of the erosion control system.

3.4 MULCHES

A. Apply mulches at the rate necessary.

B. When installed with a tackifier, apply at the rate recommended by the tackifier supplier.

C. Reapply mulch as necessary to maintain effectiveness, especially in areas prone to erosion due to wind or water.

3.5 SURFACE COVER

A. Grass, Section 32 92 00 “Turf and Grass.”

B. Ground cover, Section 32 93 13 “Ground Cover.”

3.6 MAINTENANCE

A. Maintain surfaces and supply additional topsoil where necessary, including areas affected by erosion.

B. Protect and repair geotextiles, Section 31 05 19 “Geotextiles.”

C. Keep surface of soil damp only as necessary for seed germination.

D. Apply water slowly so surface of soil will not puddle and crust.

E. Replant damaged grass areas showing root growth failure, deterioration, bare or thin spots, and eroded areas.

F. Re-fertilize 60 days after planting.

G. Remove weeds that are over three (3) inches high.

END OF SECTION

SECTION 31 31 19

VEGETATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Application of soil treatment to remove weed and vegetation.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Submit certificate identifying composition of non-selective control herbicide.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 HERBICIDE

A. Water soluble herbicide for non-selective control of annual and perennial weeds.

PART 3 - EXECUTION

3.1 MIXING

A. Mix herbicide solution in strict accordance with manufacturer's instructions and applicable Laws and Regulations.

3.2 APPLICATION

A. Execute all work in an orderly and careful manner with due consideration for surrounding plantings that are to remain.

B. Apply herbicide solution with a shield applicator. Do not allow solution to mist, drip, drift, or splash onto desirable vegetation.

C. Apply solution according to manufacturer's recommendations seven (7) days before preparation of surface to receive additional cover material. Do not add cover material until ENGINEER reviews spraying results.

D. Do not spray under windy or adverse weather conditions.

E. Replace portions of surrounding vegetation damaged or killed through this operation.

END OF SECTION

SECTION 31 36 00

GABIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gabion for slope or bank protection and erosion control in open channels.

1.2 REFERENCES

A. ASTM Standards:

1. A313 Chromium-Nickel Stainless and Heat-Resisting Steel Spring Wire.
2. A641 Zinc-Coated (Galvanized) Carbon Steel Wire.
3. A764 Steel Wire, Carbon, Drawn Galvanized and Galvanized at Size for Mechanical Springs.

1.3 SUBMITTALS

A. Manufacturer's product data showing gabion wire twist or welded pattern, components to be used, erection and component tolerances, overall layout, typical construction details, and construction procedures.

B. Design criteria recommended by manufacturer.

1.4 QUALITY ASSURANCE

A. Manufacturer of gabion structure to train and instruct construction personnel regarding installation of gabion.

B. Do not allow any gabion structure to deform during backfill operation.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Gabions: Uniform hexagonal wire mesh woven in two (2) or 3-1/2 twist pattern with openings fabricated in such a manner as to be non-raveling and designed to provide required flexibility and strength. Wire mesh shall have deformability sufficient to permit a minimum mesh elongation equivalent to 10 percent of the unstretched length of the mesh test section without reducing the gage or tensile strength of the individual wire strands to values less than those for similar wire, one (1) gage smaller in diameter.

B. Wire: Galvanized steel, Class 3, ASTM A641:

1. Fabric: US gage 11 after galvanization.

2. Selvedges: US gage 9.

3. Binding and Connecting: US gage 13-1/2.

4. Tensile Strength: 60,000 - 75,000 (psi).

5. Elongation: 12 percent maximum.

C. Polyvinyl Chloride Coated Galvanized Wire:

1. Wire Mesh Fabric: Same diameter as galvanized with an approximate overall diameter of 0.12785 inch (galvanized wire core plus PVC coating).

2. Selvedges: Same diameter as galvanized except, galvanized wire code to be US gage 10 (0.1338 inch with an approximate overall diameter of 0.15545 inch (galvanized wire core plus PVC coating)).

3. Binding and Connecting: Same diameter as galvanized with an approximate overall diameter of 0.10825 inch (galvanized wire core plus PVC coating).

D. Fasteners: Resistant to a force of at least 900 pounds while still remaining in a locked and closed position:

1. Stainless steel, ASTM A313 for PVC coated gabions.

2. Galvanized, ASTM A764, Finish I, Class I, Type 3 with the same weight of coating as specified in ASTM A641.

E. Stone: Hard, durable, graded from four (4) inches to eight (8) inches diameter.

PART 3 - EXECUTION

3.1 GABION ASSEMBLY

A. Assemble base, lid, ends and sides into a single woven unit. If not woven then connect these members so that strength and flexibility at the connecting point is at least equal to that of the mesh.

B. Where length of gabion exceeds 1-1/2 times its horizontal width, divide gabion basket with diaphragms, of the same mesh and gage as the body of the gabion, into equal cells whose length does not exceed horizontal width. Secure diaphragms in position on the gabion bottom so no field tying is required.

C. Tie all untied edges with binding wire. Loop wire tightly around every other mesh opening along seams such that every other mesh opening along seams are single and double loop alternating.

3.2 PLACEMENT

A. Place empty gabions into positions indicated. Tie each unit to the adjoining unit along the vertical reinforced edges and the top selvedges.

B. Tie front and back of base of empty gabions to top of previously filled gabions.

C. Stretch gabions to achieve better alignment and finish.

D. Position fasteners at two (2) per foot of selvedge.

3.3 GABION FILLING

A. Backfilling Gabion Structures 24 inches High or Greater:

1. Backfill each unit in 12 inches thick lifts.

2. At the completion of the first backfill lift, tie one connecting wire in each direction to opposite face of each gabion cell. Loop and twist lock all connecting wires around two (2) mesh openings.

3. At the completion of the second backfill lift, tie two (2) connecting wires as above.

4. Continue above backfilling procedure until gabion structures are filled.

5. Tie gabion structure lid to the rest of the basket.

B. Backfilling Gabion Structures 18 inches High or Less:

1. Backfill each unit in lifts 1/2 the thickness of the gabion structure.

2. At the completion of the first backfill lift, tie two (2) connecting wires in each direction. Complete wire tying and backfill operation as above.

END OF SECTION

SECTION 31 37 00

RIPRAP OR ROCK LINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Placement of loose riprap, hand-placed riprap, or grouted riprap.

1.2 REFERENCES

A. ASTM Standards:

1. C535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

2. D6092 Standard Practice for Specifying Standard Sizes of Stone for Erosion Control.

1.3 SUBMITTALS

A. Submit before use in the Work product data showing riprap source, gradation, aggregate wear, and placement technique.

B. Submit samples of proposed riprap materials for approval.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 AGGREGATE

A. Durable, angular, hard stone free from seams and cracks.

B. Graded in size to produce a reasonably dense mass.

C. The greatest dimension of 25 percent of the stones shall be at least, equal to but not more than 1-1/2 times the thickness of riprap indicated.

D. The greatest dimension of 50 percent of the stone shall be at least 3/4, but not more than 1-1/2 times the thickness of riprap indicated.

E. Not more than 10 percent of the aggregate shall have a dimension less than 0.1 times the thickness of riprap.

F. At least 95 percent of the stones shall have at least two (2) fractured or clean angular faces.

G. Conform to the size and gradation requirements specified in ASTM D6092 for the particular class of riprap indicated.

2.2 ACCESSORIES

A. Portland cement grout, Section 03 61 00 “Cementitious Grouting.”

B. Geotextile fabric, Section 31 05 19 “Geotextiles.”

C. Grout, Section 04 05 16 “Masonry Mortar and Grout.”

D. Filter material: Granular material or geotextile fabric used to prevent the migration of fines from underlying soil through the riprap.

2.3 SOURCE QUALITY CONTROL

A. Aggregate: Wear not greater than 40 percent when tested, ASTM C535.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove all brush, trees, stumps, and other objectionable materials and dress area to a smooth surface. Make excavation to provide a firm foundation and protect against undercutting. Secure approval before backfilling.

B. Install required geotextile in accordance with Section 31 05 19 “Geotextiles.”

C. Install filter material, as required, beneath the riprap. If granular material is used, spread it evenly and compact it to a minimum thickness specified.

3.2 LOOSE-PLACED RIPRAP

A. Place stones to secure a Rock mass with the minimum thickness and height indicated. Manipulate Rock to secure a regular surface of graded size and mass stability.

B. Ensure that riprap stones are placed on the prepared surface without damaging the underlying filter material or geotextile.

3.3 HAND-PLACED RIPRAP

A. Place and bed rocks, one against the other, and key together. Fill irregularities between stones with suitable size spalls.

B. Place so finished surface of riprap is even, tight, and true to line and grade. Extend riprap sufficiently below ground surface to secure a firm foundation.

3.4 GROUTED RIPRAP

A. After placement and wetting the stones, sweep sand or fine gravel into the interstices to fill to within four (4) inches of the outer surface of the riprap.

B. Fill the remaining volume of the interstices flush with a well-mixed grout.

C. Keep grout wet by sprinkling or covering with wet material for at least three (3) days. Protect grout from stream water or any other disturbance during this cure period.

D. Do not place grout in freezing weather.

E. Ensure proper curing of grout by maintaining the recommended temperature and humidity conditions as per manufacturer's instructions.

END OF SECTION

SECTION 31 41 00

SHORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Shoring for open Excavations requiring a Protective System.

2. Underpinning to stabilize adjacent structure.

3. Compliance with local, state, and federal regulations and safety guidelines.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.

2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.

3. Indicate type and location of waterproofing.

4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

C. Informational Submittals:

1. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

2. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

3. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. OWNER is not responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - MATERIALS

2.1 MATERIALS

A. Use materials that meet the requirements of the design, local regulations, and applicable industry standards and are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

E. Shotcrete: Comply with Section 03 37 13 "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.

F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

G. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

H. Tiebacks: Steel bars, ASTM A 722/A 722M.

I. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Conduct Preinstallation Conference at Project site and cover the following.

1. Review geotechnical report.
2. Review existing utilities and subsurface conditions.
3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
4. Review proposed excavations.
5. Review proposed equipment.
6. Review monitoring of excavation support and protection system.
7. Review coordination with waterproofing.
8. Review abandonment or removal of excavation support and protection system.

B. Make safe or remove trees, surface encumbrances that are hazardous to Shoring operations.

C. Provide adequate ventilation of Excavations.

D. Control dust and groundwater.

1. Prevent surface water from entering excavations by grading, dikes, or other means.

3.2 STABILITY OF ADJACENT STRUCTURES

A. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

B. Excavation below level of base of footing of any structural foundation or wall shall not be permitted except as follows:

1. Underpinning or other Support Systems is provided to ensure stability of structure, or
2. Excavation is in Unfractured Rock, or
3. A licensed design professional determines in writing that such work will in no way pose a hazard to persons and property or the integrity of the structure.

C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.3 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install walers horizontally at locations indicated on Drawings and secure to soldier piles.

3.4 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.5 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify ENGINEER if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

D. Do not overload Support Systems.

3.7 SHIELD SYSTEMS

A. Minimize time when Sides of an Excavation remain unsupported.

B. Do not subject Shield systems to loads other than those considered in their design.

C. Remove persons and property from Excavation when portable Shields are being relocated.

D. Ensure that the shield system is designed and installed to meet the requirements of the specific excavation conditions and in accordance with the manufacturer's recommendations.

3.8 REMOVAL OF SUPPORT SYSTEMS

A. Install additional members to carry loads imposed upon the Support System when temporary removal of individual members is necessary.

B. When removing Support System, release member by member slowly to avoid Failure of the remaining members or cave-ins.

C. Coordinate backfilling to minimize time an unsupported Excavation remains open.

D. Ensure removal of support systems are performed under the supervision of a competent person or registered professional engineer.

E. Leave excavation support and protection systems permanently in place if required or approved by the ENGINEER.

END OF SECTION

Division 32 – Exterior Improvements

SECTION 32 01 05

INFORMATION, REGULATORY, AND WARNING SIGNS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Information, regulatory, and warning signs but not street name signs or construction signs.

2. Compliance with local, state, and federal regulations and safety guidelines.

1.2 REFERENCES

A. ASTM Standards:

1. B209: Aluminum and Aluminum - Alloy Sheet and Plate.

B. Federal Specification Standards:

1. L-P-380: Plastic Molding Material Methacrylate.

2. L-S-300: Sheeting and Tape, Reflective: Nonexposed Lens.

3. ANSI Z535: American National Standard for Safety Signs.

C. National Bureau of Standards:

1. PS 1: Construction and Industrial Plywood.

D. UDOT Standards:

1. MUTCD: Manual on Uniform Traffic Control Devices for Streets and Highways, Utah Edition.

1.3 SUBMITTALS

A. Submit Shop Drawings of support structures before fabrication.

B. Submit sample of each color of reflective sheeting including manufacturer's name and product number.

C. Submit manufacturer's product data for signs, sheeting, and support structures.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. For definition purposes, the various types of signs are identified by a combination of letter and number. The letter represents the type of sign panel construction, and the number represents the type of lettering and symbols to be used as follows:

1. Panel Type:

a. Type A: Reflectorized sheeting on sheet aluminum.

b. Type B: Reflectorized sheeting on plywood.

2. Letter Type:

a. Type 1: Reflectorized demountable cutout letters, symbols, and borders with prismatic reflectors.

b. Type 2: Opaque legend and borders.

c. Type 3: Reflectorized permanently attached cutout letters, symbols, and borders or reflectorized screen processed letters, symbols, and borders.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Sign Blank:

1. Aluminum Sheet: 0.1 inch thick ASTM B209 alloy 6061-T6.

2. Aluminum Extrusion: 0.1 inch thick ASTM B209 alloy 6063-T5 and 6063-T6.

3. Softwood Plywood: PS 1 Group 1 with each panel bearing initials DFPA Grade - Trademark of the American Plywood Association; painted to ENGINEER’s choice of color unless indicated.

B. Posts: Galvanized structural steel, U-shaped, T-shaped, C-shaped, box-shaped, or round tube, Section 05 12 00, with 3/8 inch diameter mounting holes.

C. Fabricated Supports: Galvanized steel, Sections 05 05 13 and 05 12 00 “Structural Steel Framing.”

D. Sheeting:

1. Reflective: FS L-S-300 with 2,200 hours minimum durability.

2. Nonreflective: Nonchalking, weather resistant transparent plastic having a protected adhesive backing and a smooth flat outer surface with glass spheres embedded within.

E. Prismatic Reflectors: Methyl methacrylate lens meeting FS L-P-380 requirements with aluminum frame.

F. Bolts, Nuts, Accessories: Galvanized steel, Section 05 05 23 “Metal Fastenings.”

G. Cast-in-place Concrete: Class 3000 minimum, Section 03 30 00 “Cast In Place Concrete.”

H. Fasteners: Stainless steel or non-corrosive materials compatible with sign and support materials.

2.2 COLORS AND FORMAT

A. Sign Colors and Format: Per MUTCD.

B. Provide colors of same reflectorized hue in daylight and night under artificial white illumination.

C. Follow ANSI Z535 standard for additional safety sign formats, colors, and symbols when applicable.

PART 3 - EXECUTION

3.1 PREPARATION

A. Locate and protect existing utilities. Excavation shall be performed per Section 31 23 16.

3.2 INSTALLATION

A. Do not remove a sign that is being replaced until the new sign is placed and uncovered. Provide temporary covering. Maintain covering until removal.

B. Unless otherwise indicated, use clearance and locations shown in the MUTCD. Install posts plumb and in proper alignment. Construct sign post foundations with concrete, ensuring foundations are finished slightly above natural ground level to protect the post material.

C. Establish proper elevation and orientation of all signs, structures, and determine proper sign post lengths as dictated by construction slopes.

D. Construct overhead support structures where indicated with signs horizontal and perpendicular to roadway. Minimum allowable vertical clearance from high point of pavement is 16.5 feet.

E. Install signs at heights and lateral clearances in accordance with MUTCD and local requirements.

F. Install signs with proper visibility, unobstructed by trees, bushes, or other obstructions.

G. Install signs on supports designed to resist wind loads in accordance with applicable building codes and standards.

3.3 WORKMANSHIP

A. Carefully fabricate and erect signs. Damage signs will be rejected.

B. Make all vertical joints and cuts flat and true.

C. Elevator bolts may be used or bolt holes relocated where conflict exists with sign border, legend, or copy.

D. Lay out and properly balance on the sign face all Type 1 legend and copy before fastening. Plug holes left by shifting of copy or legend with the same type screw used to fasten the legend.

E. Wash all sign faces before final inspection, Section 01 74 13.

F. Ensure that all sign components are securely fastened and properly aligned.

G. Protect sign surfaces during installation to prevent scratches or other damage.

END OF SECTION

SECTION 32 01 06

STREET NAME SIGNS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for street name sign and components.

2. Compliance with local, state, and federal regulations and safety guidelines.

1.2 REFERENCES

A. ASTM Standards:

1. B 209 Aluminum and Aluminum-Alloy Sheet and Plate.

B. MUTCD: Manual on Uniform Traffic Control Devices for Streets and Highways.

C. FS Standards:

1. L-S-300 Sheeting and Tape, Reflective: Nonexposed Lens.

D. Related Sections:

1.3 SUBMITTALS

A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Blanks:

1. Aluminum Sheet: 0.1-inch-thick ASTM B209 alloy 6061-T6, of the height indicated with length required to spell the street name (18, 24, 30, 36, 42, 48 inches).

2. Nonmetallic: Fiberglass reinforced composite bonded with a thermosetting polymer and the following properties:

a. Tensile strength (transverse), 5,000 psi minimum.

b. Tensile strength (longitudinal), 25,000 psi minimum.

c. Lengths as required to spell the street name (18, 24, 30, 36, 42, 48 inches).

d. Height as indicated.

B. Reflective Sheeting: Reflective per FS L-S-300 with 2,200 hours minimum durability.

C. Sign Lettering: White upper case and lower-case letters, reverse silk screened on white with specified background color transparent ink.

D. Letter Composition: Spell out street name and give numerical coordinate on the right hand side; include neighborhood logo, if applicable, on the left hand side. Font as indicated.

E. Rail for Sign Blank: Tensile strength 40,000 psi minimum.

F. Posts: Galvanized structural steel, U-shaped, T-shaped, C-shaped, box-shaped, or round tube per Sections 05 12 00 and Section 05 05 10 requirements, with 3/8 inch diameter mounting holes.

G. Bolts, Nuts, Accessories: Galvanized steel, Section 05 05 23 “Metal Fastenings.”

H. Fasteners: Stainless steel or non-corrosive materials compatible with sign and support materials.

2.2 COLORS AND FORMAT

A. Sign Colors and Format: MUTCD and local requirements.

B. Follow local regulations and requirements for letter sizing and visibility.

C. Cast-in-place Concrete: Class 3000 minimum, Section 03 30 00 “Cast In Place Concrete.”

PART 3 – EXECUTION

3.1 PREPARATION

A. Locate and preserve utilities, Section 01 31 22 “Locating and Preserving Utilities.”

B. Excavation, Section 31 23 16 “Excavation.”

3.2 INSTALLATION

A. Ensure that all sign components are securely fastened and properly aligned.

B. Protect sign surfaces during installation to prevent scratches or other damage.

C. Inspect signs for legibility and proper reflectivity after installation.

D. Set posts two (2) feet deep and anchored in concrete.

E. Provide 10 feet high clearance from the ground level to the bottom of sign.

F. Install posts plumb so closest edge of sign is two (2) feet from vertical projection of the curb face at the point of curve (PC) of the intersection approach curb.

G. Restore all surfaces damaged during installation.

END OF SECTION

SECTION 32 01 07

RELOCATE POST MOUNTED SIGNS AND MAILBOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Relocate post mounted signs.
2. Relocate mailboxes to supports approved by USPS.
3. Compliance with local, state, and federal regulations and safety guidelines.

1.2 REFERENCES

A. USPS Standards:

1. Mailbox requirements.

B. DOT Standards:

1. MUTCD: Manual on Uniform Traffic Control Devices for Streets and Highways.

1.3 SUBMITTALS

A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. Post Mounted Signs: Street name signs and traffic control signs such as regulatory signs, warning signs, guide signs, detour, and closure signs.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Cast-in-place: Class 3000 minimum, Section 03 30 00 “Cast In Place Concrete.”

B. Concrete Mix Design: Comply with Section 03 30 00 “Cast In Place Concrete.”

2.2 MAILBOX SUPPORTS

A. Wood: Salt treated fir, hemlock or pine for post, shelf and brace. Grade: No. 2 or better.

B. Metal: Galvanized or dark epoxy painted steel post, shelf, and brace with no defects.

PART 3 - EXECUTION

3.1 PREPARATION

A. Locate and preserve utilities.

B. Excavate, Section 31 23 16 “Excavation.”

C. Reuse existing mailboxes, street signs and posts unless indicated otherwise.

3.2 EXISTING TRAFFIC CONTROL SIGNAGE

A. Maintain all existing traffic control and street signs in full view of the intended traffic.

B. Coordinate post mount sign relocations such that view of existing traffic control and street signs is maximized.

C. Ensure that relocated signs maintain the same orientation and visibility as the original installation.

3.3 SIGN RELOCATION

A. Maintain existing signs until construction requires removal. Coordinate with ENGINEER 24 hours in advance of removal of any sign.

B. Relocate existing street signs indicated or ordered by OWNER/ENGINEER.

C. Remove concrete from existing posts where posts are to be reused.

D. Protect new signs and posts until Project is accepted.

E. Reset post in concrete, eight (8) inches in diameter to depth indicated or ordered by ENGINEER.

F. Inspect and clean signs before reinstallation.

G. Repair or replace any damaged signs or posts as directed by the ENGINEER.

H. Ensure proper sign height and orientation as per MUTCD and local requirements.

I. Completely fill and compact hole left by removing signpost. Match adjacent surface.

3.4 MAILBOX RELOCATION

A. Completely remove all designated mailbox posts and footings.

B. Furnish and install new posts, shelf, and brace.

C. Relocate existing mailboxes indicated or ordered by ENGINEER.

D. Attach box firmly to shelf and post.

E. Coordinate with local USPS office regarding temporary and permanent mailbox relocations.

F. Ensure that relocated mailboxes meet USPS height and setback requirements.

G. Repair any damage done to mailbox during moving or replace if irreparable to ENIGNEER's and mailbox owner's satisfaction.

H. Compact soil around post and provide firm support.

I. Provide support for temporary mailbox as required during construction at no extra cost to OWNER, with temporary mailbox located in accordance with United States Postal Service requirements.

J. Restore original location of box to condition equivalent to adjacent area.

3.5 PAVEMENT MARKINGS

A. Pavement marking shall be per Section 32 17 23 "Pavement Markings."

B. Remove or cover existing pavement markings in conflict with relocated signs or mailboxes, as directed by the ENGINEER.

END OF SECTION

SECTION 32 01 10

RELOCATE FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Reset existing fences and gates in new locations.
2. Repair or replacement of damaged or unsuitable fence components.

1.2 REFERENCES

A. Related Sections:

1. Section 32 31 19 “Decorative Metal Fences and Gates”
2. Section 32 31 13 “Chain Link Fences and Gates”
3. Section 32 31 16 “Welded Wire Fences and Gates”
4. Section 03 30 00 “Cast in Place Concrete”
5. Section 31 23 16 “Excavation”

1.3 SUBMITTALS

A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Nails, Spikes and Staples: Galvanized steel for exterior, high humidity locations, and treated wood. Size and type to suit applications.

B. Chain Link Fences and Gates: Section 32 31 13.

C. Welded Wire Fences and Gates: Section 32 31 16.

D. Cast in Place Concrete: Class 3000 minimum, Section 03 30 00.

2.2 FENCE AND GATE HARDWARE

A. Provide new, matching hardware for relocated fence and gate components, as required.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate locating utilities.

B. Excavation, Section 31 23 16 “Excavation.”

C. Notify ENGINEER of any discrepancies or conflicts in existing fence locations, materials, or conditions before proceeding with relocation.

3.2 INSTALLATION

A. Completely remove all existing posts, footings, wires, gates, and other items used in fencing.

B. Remove concrete on posts. Reuse posts, wire, and gates from existing fence.

C. Replace any fencing materials and gates that are damaged, lost, or broken during fence and gate relocations. Provide new materials as required which meets Specifications, for fence and gates of the same type.

D. Set relocated fences and gates straight and true.

E. Fill in old post holes unless they become part of new construction.

F. Reset posts in concrete, eight (8) inches in diameter to depth indicated or two (2) feet minimum.

G. Adjust gate hinges, latches, and other hardware for smooth operation and proper alignment.

3.3 CLEANING AND PROTECTION

A. Clean relocated fence and gate components, removing dirt, debris, and any materials that may cause damage or staining.

B. Protect relocated fence and gate components from damage during the remainder of construction.

END OF SECTION

SECTION 32 01 13.50

FOG SEAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Application of a surface rejuvenator (hot liquid asphalt emulsion) over a pavement surface that has aged at least nine (9) months.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Product data including manufacturer's literature and installation instructions.

B. Traffic control and notification plan.

C. Construction equipment list.

D. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 WEATHER

A. Apply sealer seal when air and roadbed temperatures in the shade are between 50 and 80 deg F the temperature restrictions may be waived only upon written authorization from ENGINEER.

B. Do not apply sealer during rain, fog, dust, or other unsuitable weather.

PART 2 - PRODUCTS

2.1 ASPHALT BINDER MATERIALS

A. Select from the following:

1. Emulsified asphalt: grade SS-1h, Section 32 12 03 "Asphalt Binders."

2. Cationic emulsified asphalt: grade CSS-1h, Section 32 12 03 "Asphalt Binders."

3. Cationic quick set asphalt: grade CQS-1h, Section 32 12 03 "Asphalt Binders."

4. Cationic asphalt emulsion with gilsonite ore.

B. Rejuvenators:

1. Asphalt and maltene oil with polymer mix.

2. Maltene oil base.

3. Latex: Two (2) parts latex to 100 parts asphalt emulsion.

2.2 MIX DESIGN

A. Emulsified asphalt and water dilution ratios.

1. Ratio of 1:1 for most applications.

2. Ratio of 2:1 for use on hills where runoff may be of concern or on existing very rough surface texture pavements.

2.3 SAND

A. Section 31 05 13 “Common Fill.”

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Standard bituminous spreader with triple coverage spray bar.

3.2 PREPARATION

A. Plane off or grind off existing painted lines, grease or oil patches, and spillage of any material that has adhered to pavement.

B. Remove all dust, dirt and debris.

C. Apply crack sealant, Section 32 01 17 “Sealing Cracks in Bituminous Paving”, if indicated.

D. Clean surface by water flush. Do not flush over cracks. Complete flush 24 hours prior to application of seal. Surface must be completely dry prior to application.

3.3 APPLICATION

A. Follow sealant manufacturer’s recommendations in regard to fogging of substrate, priming of substrate, and dilution of sealer.

B. Application Rate: Use the following as a guide. If surface completely absorbs emulsion with ability to absorb more, increase application rate.

Table 1 – Application Rate				
Dilution	Rate, Gal/sq. yd.	Temperature, deg F		
		Target	Minimum	Maximum
1:1	0.10 to 0.15	150	90	190
2:1	0.08 to 0.12			

C. Stop application if any spray bar nozzle is not working properly.

D. Blot areas with too much emulsion by spreading a light, uniform layer of sand.

3.4 PROTECTION

A. Protect all structures, including curb and gutter, sidewalks, guardrails and guide posts from being spattered or marred. Remove any spattering, over-coating, or marring at no additional cost to City.

B. Do not discharge bituminous material into borrow pits or gutters.

C. Prevent tracking of seal coats onto adjacent surfaces.

3.5 OPENING TO TRAFFIC

A. Keep traffic off surface until material is no longer tacky and will not track out. Material should set between 4 to 6 hours after application.

B. To allow traffic on surface prior to complete setting of the emulsion, CONTRACTOR may lightly sand surface at no additional expense to the OWNER.

C. CONTRACTOR is responsible for any claims for damage.

END OF SECTION

SECTION 32 01 13.52

MASTIC SEAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Application of an asphalt-aggregate *mastic* seal coat as a high-density roadway surface preservation treatment.

1.2 REFERENCES

A. AASHTO Standards:

1. T85 Specific Gravity and Absorption of Coarse Aggregate.
2. T308 Determining the Asphalt Binder Content of Hot-Mix Asphalt (HMA) by the Ignition Method.
3. T327 Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus.

B. ASTM Standards:

1. T327 Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus.
2. C117 Material Finer Than 0.075mm Sieve in Aggregate.
3. C131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
4. C136 Sieve Analysis of Fine and Coarse Aggregates.
5. D5 Penetration of Bituminous Materials.
6. D244 Emulsified Asphalts.
7. D3628 Selection and Use of Emulsified Asphalts.
8. D3666 Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials.
9. D6934 Residue by Evaporation of Emulsified Asphalt.
10. D6937 Determining Density of Emulsified Asphalt.
11. E1911 Measuring Paved Surface Frictional Properties Using the Dynamic Friction Tester.

C. ISSA Standards:

1. TB 100Wet Track Abrasion of Slurry Surfaces, Modified.

1.3 SUBMITTALS

A. Mix Design: Provide the following. Allow ENGINEER 10 days to evaluate the submittal. Do not mix aggregate and emulsions designated for other public or private projects.

1. Date of mix design. If older than 60 days from date of submission, recertify mix design.

2. Proportions of aggregate, filler, water, polymer, and emulsion in the mix.

3. Residual in-place bitumen content, in *pounds per square yard*.

4. Residual in-place aggregate or mineral solids content, in *pounds per square yard*.

5. Thickness target for each application coat, in *gallons per square yard*.

6. Total minimum thickness, in *gallons per square yard*.

7. Results of a wear resistance or wet track abrasion test current within one (1) calendar year of the proposed mix design.

B. Before Placement: Submit 48 hours before delivery.

1. Traffic control plan, Section 01 55 26 “Traffic Control.”

2. List of construction equipment to be used.

3. Certification from emulsion supplier stating emulsion meets requirements in this section.

4. Names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM standards.

5. Warranty.

C. Reports: If requested by ENGINEER, submit the following.

1. List of five (5) projects that have successful product application on bituminous surfaces. Provide names of project contacts.

2. Source and field quality control testing reports performed by CONTRACTOR and Suppliers.

1.4 QUALITY ASSURANCE

A. Foreman of CONTRACTOR's crew or Supplier's representative has completed at least three (3) projects of similar scope. If crew foreman does not have such experience, Supplier must provide a full-time representative on site during application.

B. Use a laboratory that complies with ASTM D3666 and follows Section 01 45 00 "Quality Control" requirements.

C. Verify mixture delivered to site contains the same emulsion specified in the mix design.

D. Do not change source of the asphalt emulsion or aggregate without supporting changes in the mix design.

E. Reject product or work that does not meet requirements.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 WEATHER

A. Temperature:

1. Apply seal coat when air and pavement surface temperatures in the shade are 55 deg F and rising.

2. Cease application if air or pavement surface temperatures are projected to fall below 40 deg F within 48 hours.

B. Moisture and Wind:

1. Do not apply seal coat to a wet surface (no visible standing water or high sheen), during rain, 24 hours prior to forecast rain, or in unsuitable windy weather.

2. Cease work if weather or other conditions prolong opening pavement surface to traffic.

1.7 NOTICE

A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying surface treatment material.

B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.

C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.

D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

E. Should work not occur on specified day, issue an updated notice advising when work will be performed.

1.8 ACCEPTANCE

A. General:

1. Acceptance is by Lot.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring complying material as part of its installation, Section 01 29 00 “Payment Procedures.”

3. Opening surface treatment to vehicular traffic does not constitute acceptance.

4. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing: however, may be used by ENGINEER for acceptance if quality requirements are met.

B. Asphalt Binder:

1. Lot size is total contracted product placement.

2. Sub-lot size is one day production.

3. Of all sub-lot samples collected, randomly select one sub-lot and test it for physical properties in this section. The lot is acceptable if tests on this sub-lot sample meets requirements. If the sample does not meet requirements, continue testing other samples for a sample that complies.

4. Pay Reduction: At ENGINEER’s discretion, a lot with a deficient sub-lot test may be accepted if pay for the lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject.

Pay Factor	Number of Non-complying Tests
1.00	0
0.95	1
0.90	2
0.85	3
Reject	4

C. Placement:

1. Mat appearance

a. No runoff onto concrete curbs, gutter pans, and shoulders.

b. No streaking, drag marks, or squeegee marks.

c. No light spots.

d. No de-bonding.

e. Straight longitudinal edges with proper joints.

2. Mat thickness, bitumen content and aggregate content.

a. Lot size is one (1) day production. Sub-lot size is 0.5 lane mile.

b. Collect and test five (5) equally spaced samples from the initial sub-lot. Upon review of the initial sub-lot test results and at ENGINEER's discretion, acceptance of subsequent sub-lots may be based upon one or less samples from each subsequent sub-lot.

3. Pay Adjustment: Not applicable. Correct mat placement deficiencies at no additional cost to OWNER.

1.8 WARRANTY

A. Both the CONTRACTOR and Supplier shall provide a two (2) year minimum written warranty when the existing pavement is in an appropriate condition (CONTRACTOR and Supplier to determine condition). Warranty covers delaminating, peeling and pre-mature surface wear.

B. Before placement, notify ENGINEER if pavement condition or application condition voids the warranty.

C. ENGINEER may allow or cancel product application at no cost to OWNER if warranty cannot be given.

D. Acceptable performance after two (2) year period is no delaminating, peeling, or inter-aggregate loss in surface wear. Mechanical disturbances by snow plow chatter, studded tires, etc. are excluded from warranty. Repair defective coverage at no additional cost to OWNER.

PART 2 - PRODUCTS

2.1 ASPHALT BINDER

A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.

B. Tack Coat: SS-1 or CSS-1, Section 32 12 13.13. Use a tack coat that is compatible with seal coat application.

C. Emulsified Asphalt: Grades SS-1, SS-1H, CSS-1, or CSS-1h, selected in accordance with ASTM D 3628 and the following.

Table 1 – Asphalt Properties

	Standard	Min	Max
Tests on Emulsion			
Viscosity at 25 deg C, seconds	D 244	15	100

Particle Charge Test (a)		Positive	
Residue by distillation, percent		57	--
Tests on Residue from Evaporation			
Penetration at 25 deg C, 100 g, 5 seconds	D 5	15	150

NOTES:

1) In case of inconclusive particle charge, material having a pH value of 6.0 will be acceptable as a CSS type.

2.2 AGGREGATE

A. Material: Clean and free from organic matter or other detrimental substances. Light weight with the following properties.

Table 2 - Aggregate Properties

	Standard	Min	Max
Water absorption, percent	T 85	--	10
Wear (hardness or toughness), percent	C 131	--	50
Micro-Deval, percent (b)	T 327	--	20

NOTES:

1) Test results are on aggregate received before blending into sealer.

2) Micro-Deval wear of aggregate retained on No. 60 sieve.

B. Gradation: Analyzed on a dry weight and percent passing basis.

1. Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum.

2. Target Grading Curve must lie within the Master Grading Band.

Table 3 – Master Grading Band and Target Tolerance Limits			
Sieve	**Standard**	**Master Grading Band Limits Percent Passing**	**Target Tolerance**
No. 8	C136	100	
No. 16		80 - 100	+/- 5
No. 30		75 - 100	+/- 5
No. 60		50 - 85	+/- 5
No. 100		40 - 65	+/- 5
No. 200	C117	25 - 65	+/- 5
NOTES: 1) Test results are on aggregate received before blending into sealer. 2) Target tolerance is the allowable variation from the Target Grading Curves.			

2.3 ADDITIVES

A. Use water that is clean, non-detrimental, and free from salts and contaminant.

B. Polymers, clays, other additives as necessary to achieve mix design performance.

2.4 MIX DESIGN

A. Asphalt Binder: Select type and grade of emulsified asphalt, ASTM D3628.

B. Set and Cure Time: Select to meet opening to traffic requirements.

C. Provide a mix containing a minimum of 18 percent aggregate by weight of the wet mixture meeting the following requirements.

Table 4 – Mix Properties			
	Standard	**Min**	**Max**
Tests on Mix			
Weight per gallon, pounds (a)	D6937	Report	
Solids content by evaporation at 130 C, percent (b)	D6934	48	--
Tests on Residue from Evaporation			
Asphalt binder content of cured mix, (130 deg C method), percent (d)	T308	30	--
Mineral aggregate and fines content of cured mix (130 deg C method), percent (d)	T308	50	--
Wet-track abrasion loss, (72 hour soak), g/m^2	TB100	--	80

Asphalt content by ignition method, percent (a)	T308	30	--
Dynamic friction test number, 20 km/h (e)	E1911	> 90 percent of base value	

NOTES:

1) Use the modified method to account for a fine emulsion mixture. Required for calibration of application equipment and for field control and acceptance.
2) A 500 to 1000 gram representative sample of the mix shall be dried in a suitable oven until weight loss ceases. Solids content shall then be defined as the net residual weight divided by net original weight expressed in percent. Retain this residual dried mix for AASHTO T 308 tests if required.
3) Rotational viscosity acceptable range shall be provided by the Supplier. Test device, spindle type, size and rotational speed shall be included with the submitted certification test results.
4) Due to the high binder content of the mix the sample size processed in the ignition oven may need to be adjusted to not exceed the binder content allowable for a particular model ignition oven.
5) Establish base friction value using prepared laboratory compacted slab of any ENGINEER approved mix as surface to be tested. The Dynamic Friction Test (DFT) number ratio should indicate that after application of the mastic seal, the surface retains required minimum percentage DFT number of the original pavement surface. Based on a minimum of three (3) slabs with three (3) measurements per slab. Value for information only. Will not be used for project control.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Paver: Use a continuous-flow mixing unit.

1. Capable of applying at least 15,000 square yards of material per day.
2. Equipped with full sweep agitation system to assure proper suspension of fine aggregates.
3. Equipped with an operator control station that adjusts material spread rate in accordance with project calibration process.
4. Equipped with a filtering system to catch particles that plug nozzles.
5. Equipped with a retractable spray bar capable of applying mixture without drilling. The bar should be positioned to meet calibration requirements.

B. Storage Tanks:

1. When delivering mix from the central mixing plant to a job site storage tank, use only storage tanks with a capacity to contain the entire transport load.

2. Ensure that all site storage tanks have internal full sweep mixing mechanisms and mixing capability that can provide at any given point in the tank a homogenous mix.

3.2 PREPARATION

A. **Paver Calibration**: On a test strip at least 300 feet long, determine the correct pump settings, spray bar height, and ground speed for the application equipment. Apply material with pump settings at 80 percent of maximum output (plus or minus 5 percent) and a ground speed of 300 to 400 feet per minute.

1. Do not begin or continue application without ENGINEER's knowledge of the calibration process and equipment settings.

2. Do not deviate from calibration settings without ENGINEER's knowledge.

B. **Surface Repair**: Method of payment to be determined by ENGINEER if any of the following repairs are required.

1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.

2. Providing tack coat on highly absorbent, polished, oxidized, or raveled asphalt surfaces or on brick or on Portland cement concrete surfaces.

3. Crack filling and crack sealing, Section 32 01 17 "Sealing Cracks in Bituminous Paving."

4. Pushing or shoving pavement to be repaired as follows.

a. Mill damaged area at least three (3) inches below required surface elevation. Section 32 01 16.71 "Cold Milling Bituminous Pavement."

b. Install and compact PG64-22, DM-3/4, 50 blow bituminous concrete in lifts not less than three (3) inches after compaction. - See additional requirements in Section 33 05 25 "Pavement Restoration."

C. **Masking**: Mask-off Street Fixtures, end of streets, intersections.

D. Traffic Control:

1. Implement traffic control plan requirements, Section 01 55 26 "Traffic Control." Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.

2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before applying seal coat. Unless specified otherwise, cost is included in the work of this section.

E. Cleaning:

1. Remove loose material, mud spots, sand, dust, oil, vegetation and other objectionable material.

2. Do not flush water or apply pressurized water over cracked pavement unless ENGINEER allows its' use and a sufficient time is allowed for drying.

3.3 PROTECTION

A. Trees, Plants, Ground Cover:

1. Protect trees, plants and other ground cover from damage.

2. Prune trees to allow equipment passage underneath, Section 32 01 93 “Pruning Trees.” Repair tree damage at no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalks, guard rails, guide posts, etc. from physical damage.

3.4 APPLICATION

A. General:

1. Two separate application coats are required. The first application must be thoroughly set and free of any damp areas before the second application begins.

2. Adjust application rates according to surface conditions, only after obtaining review by ENGINEER and the asphalt emulsion manufacturer.

B. Spreading:

1. Keep material delivery at a constant rate even if forward speed of lay-down machine varies.

2. Do not reduce application rate along edges or around manhole covers.

3. Apply both applications right to the edge of the pavement. Do not leave uncovered areas near curbs, Street Fixtures, or edges on either application.

4. Make straight lines at all locations.

5. Place product out to right-of-way line on side streets and intersections.

6. Use hand squeegees to spread mix in areas that cannot be reached with distribution spray bar.

a. Provide complete and uniform coverage.

b. Avoid unsightly appearance from hand work.

C. Joints:

1. Make transverse joints straight-cut butt type, not over-lap type.

2. Place longitudinal joints on lane lines. Limit overlap to three (3) inches maximum.

3. Stop and correct paving operation if longitudinal or transverse joints have uncovered areas or unsightly appearance.

D. Lines:

1. Make straight lines along lip of gutters, shoulders, end of streets, and in street intersections. No runoff on these areas will be permitted.

2. Vary edge lines no more than one (1) inch per 100 feet.

3.5 TOLERANCES

A. Each coat thickness = at least 40 percent of the total thickness.

B. Total thickness = 0.30 gallons per square yard minimum.

3.6 CONSTRUCTION EQUIPMENT

A. Emulsion density testing, ASTM D6937. If testing shows material non- compliance, remove installed product and halt operations until new material is delivered and is known to be in compliance.

B. Measure the total amounts of material installed, and verify it meets the application rate.

3.7 AFTER APPLICATION

A. Raise reflective tabs that were covered over by application.

B. Clean Street Fixtures.

C. Do not apply permanent pavement markings or striping material until layout and method of payment has been determined by ENGINEER and final application of surface treatment material has been in-place at least 10 days, or as permitted by ENGINEER. Layout must be verified by ENGINEER prior to application.

3.8 REPAIR

A. Remove delaminated or non-compliant product found after installation and apply acceptable product.

B. Remove spatter, mar and overcoat from curb, gutter, sidewalk, guard rails, guide posts, etc.

C. Remove overcoat from Street Fixtures.

D. Make edge and end lines straight. Provide a good appearance.

E. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.

F. Repair collateral damage caused by construction.

3.9 OPENING TO TRAFFIC

A. Cure time depends on type of asphalt, mixture characteristics and weather. Keep traffic off of treated surface until seal coat does not track out.

END OF SECTION

SECTION 32 01 13.61

SLURRY SEAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stone and an asphalt binder slurry evenly mixed and spread as a seal coat for roadways and thoroughfares.

1.2 REFERENCES

A. AASHTO Standards:

1. R9 Acceptance Sampling Plans for Highway Construction.

B. ASTM Standards:

1. C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
2. C117 Material Finer Than 0.075 mm Sieve in Aggregate.
3. C131 Resistance to Degradation of Small-Size coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
4. C136 Sieve Analysis of Fine and Coarse Aggregates.
5. D5 Penetration of Bituminous Materials.
6. D36 Softening Point of Bitumen (Ring-and-Ball Apparatus).
7. D242 Mineral Filler for Bituminous Paving Mixtures.
8. D1664 Coating and Stripping of Bitumen-Aggregate Mixtures. D2170 Kinematic Viscosity of Asphalts (Bitumens).
9. D2419 Sand Equivalent Value of Soils and Fine Aggregate.
10. D3319 Accelerated Polishing of Aggregates Using the British Wheel.
11. D3628 Selection and Use of Emulsified Asphalts.
12. D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
13. D3910 Design, Testing, and Construction of Slurry Seal. D5821 Determining the percentage of Fractured Particles in Coarse Aggregate.
14. D6937 Density of Emulsified Asphalt.

1.3 SUBMITTALS

A. Mix Design: Provide the following. Allow ENGINEER 10 days to evaluate the submittal. Do not mix aggregate and emulsions designated for other public or private projects.

1. Date of mix design. If older than 180 days from date of submission recertify mix design.

2. Target Grading Curve for aggregate.

3. Percentages of emulsion, aggregate, water and additives in the mix.

4. Emulsion type and time target for opening up a thoroughfare to traffic.

5. Slurry application rate.

6. Aggregate physical properties (this section article 2.4). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than 455 days from the date of submission.

B. Before Placement: Submit at least 48 hours before delivery.

1. Traffic control plan, Section 01 55 26 “Traffic Control.”

2. List of the construction equipment to be used.

3. Certification from emulsion supplier stating emulsion meets requirements in this section.

C. Reports:

1. Provide daily reports to OWNER’s representative including weight of material used, application rate, area covered. Indicate date, type, and project names.

2. Provide delivery tickets for each emulsion delivery. Include certification from manufacturer that emulsion meets specifications.

3. Submit oil quantities in CONTRACTOR’s emulsion storage tankers prior to transfer, after transfer and at the end of each working day.

1.4 QUALITY ASSURANCE

A. Foreman of paving crew has completed at least three (3) projects of similar scope.

B. Use a laboratory that follows and complies with ASTM D3740 and Section 01 45 00 “Quality Control” requirements.

C. Verify mixture delivered to site contains the same emulsion specified in the mix design.

D. Do not change source of asphalt emulsion or aggregate without supporting changes in the mix design.

E. Reject product that does not meet requirements.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by Lot.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring compiling material as part of its installation, Section 01 29 00 “Payment Procedures.”

3. Opening surface treatment to traffic does not constitute acceptance.

4. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. Asphalt Binder:

1. Lot size is total contracted product placement. Sub-lot size is one day production.

2. Of all sub-lot samples collected, randomly select one sub-lot and test it for the physical properties in this section The lot is acceptable if tests on this sub-lot sample meets requirements. If the sample does not meet requirements, continue testing other samples for a sample that complies.

3. Pay Reduction: At ENGINEER’s discretion, a lot with a deficient sub-lot test may be accepted if pay for the lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject.

Pay Factor	Number of Non-complying Tests
1.00	0
0.95	1
0.90	2
0.85	3
Reject	4

C. Aggregate: Lot size is one (1) day's production with 300 tons sub-lots. Collect Samples randomly before mixing. Test gradation, ASTM C 136. Test thickness. Lot will be acceptable if:

1. Average gradation of each sieve for the Lot is within the Target Grading Band for that sieve, and

2. Number of Samples in the Lot with any sieve measurement outside of the Target Grading Band does not exceed two (2), and

3. Material on 200 sieve does not exceed allowable.

4. Price Adjustment: Aggregate gradation defects may be accepted if 2.5 percent price reduction is applied against lot for each condition not met. Maximum price reduction for a lot is five (5) percent.

D. Placement:

1. Mat Appearance:

a. No runoff onto concrete curbs, gutter pans, and shoulders.

b. No streaking, drag marks or squeegee marks.

c. No light spots.

d. No de-bonding.

e. Straight longitudinal edges with proper joints.

2. Price Adjustment: Not applicable. Correct deficiencies at no additional cost to OWNER.

1.6 WEATHER

A. Temperature:

1. Apply seal coat when air and pavement surface temperatures in the shade are 45 deg F and rising.

2. Cease application if air or pavement temperatures are below 55 deg F and falling or if the finished product will freeze before 24 hours.

B. Moisture and Wind:

1. Do not apply seal coat to a wet surface (no visible standing water or high sheen), during rain, if humidity prolongs curing, or in unsuitable windy weather.

2. Cease work if weather or other conditions prolong opening pavement surface to traffic.

1.7 NOTICE

A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying seal coat.

B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.

C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.

D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

E. Should work not occur on specified day, issue an updated notice advising when work will be performed.

PART 2 - PRODUCTS

2.1 ASPHALT BINDER

A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.

B. Tack Coat: SS-1 or CSS-1, Section 32 12 13.13 “Tack Coat.” Use a tack coat that is compatible with seal coat application.

C. Emulsified Asphalt: Unless specified elsewhere provide CQS-1h quick traffic type, ASTM D3628 with a two (2) hour return to traffic quickset. Provide the following properties.

Table 1 – Physical Properties

	Standard	Target	Min	Max
Tests on Emulsion				
Viscosity at 25 deg C, second	D 244	32	15	90
Sieve test, percent		0.01	--	0.30
Settlement, 5 day, percent		3.5	--	5
Storage stability, 1 day, percent		0.6	--	1
Residue by distillation, percent		64.2	60	--
Tests on Residue from Evaporation				
Penetration at 25^{O} C, 0.1 mm	D 5	51	40	90
Softening point, deg. C.	D 36	60	57	--
Kinematic viscosity, cSt/sec	D 2170	--	650	--
Saybolt furol viscosity at 77^{O} F., seconds		--	--	50
Polymer solids based on mass of residual asphalt, percent	--	3 to 6	3	--

NOTES:

1) Polymer is a solid synthetic rubber or latex material.
2) Cement mixing test waived.
3) Polymer solids are to be milled or blended into the asphalt or emulsifier solution before the emulsification process.

2.2 AGGREGATE

A. Material: Stone, slag, or other high-quality particle or combination clean and free from organic matter or other detrimental substances with the following properties.

Table 2 – Aggregate Properties

		Standard	Min	Max
Angularity (fractured faces), percent		D 5821	80	--
Wear (hardness or toughness), percent		C 131	--	35
Soundness (weight loss in 5 cycles), percent		C 88	--	10
Clay content (sand equivalent), percent	SS Type I	D 2419	45	--
	SS Type II	D 2419	55	--
	SS Type III	D 2419	60	--
Polishing, BPN		D 3319	28	--
Water absorption, percent		--	--	1.25

NOTES:

1) Angularity of aggregate retained on No. 4 sieve with at least one (1) mechanically fractured face or clean angular face. Provide 100 percent (maximum) for thoroughfares with a Road Class III (Section 32 12 05).
2) Wear of aggregate retained on No. 12 sieve after 500 revolutions.
3) Soundness for combined coarse and fine aggregate measured using five (5) cycles Na_2SO_4.
4) Clay content before additives.

B. Gradation: Analyzed on a dry weight and percent passing basis.

1. Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum.

2. Target Grading Curve must lie within one (1) of the following Master Grading Bands. Field Samples shall not vary from the Target Grading Curve by more than the Target Tolerance.

Table 3 – Master Grading Band and Target Tolerance Limits

Sieve	Standard	Master Grading Band Limits Percent Passing			Target Tolerance
		SS Type I	SS Type II	SS Type III	
3/8 in.	C136	--			--
No.4		100			+/- 5
No. 8		90-100			+/- 5
No. 16		65-90			+/- 5
No. 30		40-65			+/- 5
No. 50		25-42			+/- 4
No. 100		15-30			+/- 3
No. 200	C117	10-20			+/- 2

NOTES:

1) Target tolerance is the allowable variation from the Target Grading Curve.
2) Portion retained on the No. 4 sieve clean and free of clay coatings.
3) Portion passing No. 200 sieve includes mineral filler.

2.3 ADDITIVES

A. Use water that is clean, non-detrimental, and free from salts and contaminant.

B. Mineral Filler: ASTM D242.

C. Portland cement, hydrated lime, limestone dust, fly ash, or aluminum sulfate to regulate setting time and improve workability.

D. Limestone dust, fly ash, and rock dust to alter aggregate gradation.

2.4 MIX DESIGN

A. Asphalt Binder: Select type and grade of emulsified asphalt, ASTM D3628.

B. Proportioning: Use the consistency test of ASTM D3910 to determine optimum ratio of aggregate, filler, water, and emulsion.

C. Set and Cure Time: Select to meet opening to traffic requirements.

D. Stripping: More than 90 percent of bituminous-coated particles retain asphalt coating, ASTM D1664.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Paver: Use a continuous-flow mixing unit:

1. Capable of applying at least 15,000 square yards of material per day.

2. Capable of accurately delivering a predetermined portion of aggregate, water, and asphalt emulsion to the mixing chamber.

3. Prevent loss of slurry from the distributor by using a mechanical type squeegee distributor equipped with flexible material in contact with the pavement surface.

4. Has a lateral control device and a flexible strike-off capable of being adjusted to lay the slurry at the mix design application rate.

3.2 PREPARATION

A. Meter Calibration: On a test strip at least 500 feet long, determine the correct meter settings on the mixing equipment. The settings are to produce a product that complies with the following:

1. Set time 30 minutes maximum. Initial set occurs when blotting the surface of the material yields only water (no emulsion).

2. No distress when exposed to traffic two (2) hours after placement.

B. Surface Repair: Method of payment to be determined by ENGINEER if any of the following repairs are required.

1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.

2. Providing tack coat on highly absorbent, polished, oxidized, or raveled bituminous pavement or on brick or on Portland cement concrete surfaces.

3. Crack filling and crack sealing, Section 32 01 17 “Sealing Crack in Bituminous Paving.”

4. Pushing or shoving pavement to be repaired as follows.

   a. Mill damaged area at least three (3) inches below required surface elevation. Section 32 01 16.71 “Cold Milling Bituminous Pavement.”

   b. Install and compact PG64-22, DM-3/4, 50 blow bituminous concrete in lifts not less than three (3) inches after compaction. See additional requirements in Section 33 05 25 “Pavement Restoration.”

C. Masking: Mask-off Street Fixtures, end of streets, intersections.

D. Traffic Control:

1. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.” Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.

2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before applying seal coat. Unless specified otherwise, cost is included in the work of this section.

E. Cleaning:

1. Remove loose material that may cause drag marks.

2. Remove mud spots, sand, dust, oil, vegetation, and other objectionable material.

3. Do not flush water or apply pressurized water over cracked pavement unless ENGINEER allows its' use and a sufficient time is allowed for drying.

3.3 PROTECTION

A. Trees, Plant, Ground Cover:

1. Protect trees, plants, and other ground cover from damage.

2. Prune trees to allow equipment passage underneath, Section 32 01 93 “Pruning Trees.” Repair tree damage to no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalks, guard rails, guide posts, etc. from physical damage.

3.4 APPLICATION

A. General:

1. Machine meter settings must match mix design. Water and additives may be adjusted (per mix design) for better consistency or set time.

2. Wait at least two (2) hours if an adjacent pass has broken and started to cure.

3. The seal coat, when cured shall present a uniform, skid-resistant appearance with all cracks filled.

4. Do not apply lane marking tape or paint for traffic control until layout and placement has been verified with ENGINEER.

B. In the Spreader Box:

1. Do not exceed four (4) minutes total mixing time.

2. No additional water.

3. No lumping, balling or unmixed aggregate.

4. No segregation of the emulsion and aggregate fines from the coarse aggregate.

5. No breaking of emulsion.

6. No overloading. Carry a sufficient amount of slurry in all parts of the spreader box for complete coverage.

C. Spreading:

1. Dampen surface immediately before application of surface treatment (prevents premature breaking and improves bonding). All surfaces are to be uniformly damp with no free water standing on the surface or in cracks.

2. Keep material delivery at a constant rate even if forward speed lay- down machine varies.

3. Do not reduce application rate along edges or around manhole covers.

4. Apply seal coat right to the edge of the pavement. Do not leave uncovered areas near curbs, Street Fixtures, or edges.

5. Make straight lines at all locations.

6. Place seal coat out to right-of-way line on side streets and intersections.

7. Use hand squeegees to spread mix in areas that cannot be reached with distribution spray bar.

    a. Provide complete and uniform coverage.

b. Avoid unsightly appearance from hand work.

8. If coarse aggregate settles to bottom of mix, remove slurry from pavement.

D. Joints:

1. Make transverse joints straight-cut butt type, not over-lap type.

2. Place longitudinal joints on lane lines. Limit overlap to three (3) inches maximum.

3. Tolerance for joint match is 1/4 inch difference in elevation when measured with a 10 feet long straight edge over the joint.

4. Stop and correct paving operation if longitudinal or transverse joints have uncovered areas or unsightly appearance.

E. Lines

1. Make straight lines along lip of gutter, shoulders end of streets, and in street intersections. No runoff on these areas will be permitted.

2. Vary edge lines no more than one (1) inch per 100 feet.

3.5 TOLERANCES

A. Thickness: Measured in pounds per square yard. Standard application rate applies unless specified elsewhere.

Slurry	Standard	Heavy
SS Type I	8 to 12	10 to 13
SS Type II	12 to 16	15 to 18
SS Type III	15 to 18	22 to 25

3.6 FIELD QUALITY CONTROL

A. Emulsion density testing, ASTM D6937. If testing shows material non- compliance, remove installed product and halt operations until new material is delivered and is known to be in compliance.

B. If an ASTM C136 sieve analysis shows aggregate gradation non- compliance, either remove the material or blend in other aggregates to bring it into compliance. This may require a new mix design. Screening may be required at the stockpile to remove any defective material.

C. Measure the total amounts of material installed, and verify it meets the application rate. Make all emulsion deliveries in the presence of OWNER’s representative.

3.7 AFTER APPLICATION

A. Raise reflective tabs that were covered over by application.

B. Clean Street Fixtures.

C. Leave no streaks caused by oversized aggregate particles or buildup on squeegees.

D. Leave no holes, bare spots, or cracks. The seal coat shall be uniform and skid-resistant when cured.

E. Do not apply permanent pavement markings or stripe material until layout and method of payment has been determined by ENGINEER and final application of seal coat has been in-place at least 10 days, or as permitted by ENGINEER. Layout must be verified by ENGINEER prior to application.

3.8 REPAIR

A. Remove delaminated or non-compliant product found after installation and apply acceptable product.

B. Remove spatter, mar and overcoat from curb, gutter, sidewalk, guard rails, guideposts, etc.

C. Remove overcoat from Street Fixtures.

D. Make edge and end lines straight. Provide good appearance.

E. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.

F. Repair collateral damage caused by construction.

3.9 OPENING TO TRAFFIC

A. Cure time depends on type of asphalt, mixture characteristics and weather. Keep traffic off of treated surface until seal coat does not track- out.

END OF SECTION

SECTION 32 01 13.64

CHIP SEAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphalt binder and cover aggregate evenly spread as a uniform, skid- resistant seal coat on roadways and thoroughfares.

2. Application of a slurry seal over a chip seal (cape seal) if specified.

1.2 REFERENCES

A. ASTM Standards:

1. C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

2. C117 Amount of Material Finer Than 0.075 mm Sieve in Aggregate.

3. C131 Resistance to Degradation of Small-Size coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

4. C136 Sieve Analysis of Fine and Coarse Aggregates.

5. C142 Clay Lumps and Friable Particles in Aggregates.

6. D5 Penetration of Bituminous Materials.

7. D36 Softening Point of Bitumen (Ring and Ball Apparatuses).

8. D242 Mineral Filler for Bituminous Paving Mixtures.

9. D1664 Coating and Stripping of Bitumen-Aggregate Mixtures.

10. D2170 Kinematic Viscosity of Asphalts (Bitumens).

11. D2419 Sand Equivalent Vlue of Soils and Fine Aggregate.

12. D3319 Accelerated Polishing of Aggregates Using the British Wheel.

13. D3628 Selection and Use of Emulsified Asphalts.

14. D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

15. D3910 Design, Testing, and Construction of Slurry Seal.

16. D4791 Flat or Elongated Particles in Coarse Aggregate.

17. D5821 Determining the percentage of Fractured Particles in Coarse Aggregate.

1.3 SUBMITTALS

A. Mix Design: Provide the following. Allow ENGINEER 10 days to evaluate the submittal. Do not mix aggregate and emulsions designated for other public or private projects.

1. Date of mix design. If older than 60 days from date of submission, recertify mix design.

2. Type and grade of asphalt binder to be used (if not specified).

3. Target Grading Curve for aggregate.

4. Asphalt and aggregate compatibility.

5. Asphalt additives.

6. Asphalt and aggregate application rates.

7. Aggregate physical properties (this section article 2.2. The information is for suitability of source and not for project control. Test results shall not be older than 365 days from the date of submission.

B. Before Placement: Submit 48 hours before delivery:

1. Traffic control plan, Section 01 55 26.

2. List of construction equipment to be used.

3. Certification from emulsion supplier stating emulsion meets requirements in this section.

C. After Installation: Submit the asphalt bill of lading. Identify weight of asphalt, weight of emulsified asphalt (after water has been added).

D. Reports: If requested by ENGINEER, submit source and field quality control testing reports performed by CONTRACTOR and Suppliers.

1.4 QUALITY ASSURANCE

A. Foreman of CONTRACTOR’s crew has completed at least three (3) projects of similar scope.

B. Use a laboratory that follows and complies with ASTM D3740 and Section 01 45 00 “Quality Control” requirements.

C. Do not change source of asphalt emulsion or aggregate without supporting changes in the mix design.

D. Reject product that does not meet requirements.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by Lot.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring seal coat as part of its installation. Section 01 29 00 “Payment Procedures.”

3. Dispute resolution, Section 01 35 10.

4. Opening chip seal surface to traffic does not constitute acceptance.

5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. Asphalt Binder:

1. Lot size is total contracted product placement. Sub-lot size is one day production.

2. Of all sub-lot samples collected, randomly select one sub-lot and test it for the physical properties in this section. The Lot is acceptable if tests on this sub-lot sample meets requirements. If the sample does not meet requirements, continue testing other samples for a sample that complies.

3. Pay Reduction: At ENGINEER’s discretion, a lot with deficient sub-lot tests may be accepted if pay for lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject.

Pay Factor	Number of Non-complying Tests
1.00	0
0.95	1
0.90	2
0.85	3
Reject	4

C. Aggregate:

1. Verify suitability of aggregate source.

2. Lot size is one (1) day production with 500 tons sub-lots. Collect samples randomly from the hauling equipment. Test gradation, ASTM C 136. Lot will be acceptable if:

a. Average gradation of each sieve for lot is within the Target Grading Band for that sieve, and

b. Number of samples in lot with any sieve measurement outside of the Target Grading Band does not exceed two (2), and

c. Material on 200 sieve gradation does not exceed allowable.

3. Price Adjustment: Aggregate gradation defect may be accepted if 2.5 percent pay factor is applied against lot for each condition not met. If a lot has multiple defective sub-lots, maximum cumulative pay factor for a lot is five (5) percent.

D. Placement:

1. Asphalt Binder:

a. No runoff onto concrete curbs, gutter pans, shoulders, etc.

b. No streaking, drilling, bare spots.

c. No light spots.

d. Uniform with no ridging.

2. Aggregate:

a. Asphalt See-through: Not more than 15 percent black (asphalt) can be seen through the newly laid and compacted rock chip after sweeping.

b. Embedment: After rolling and evaporation, random sampling reveals large particles are embedded in the asphalt binder on their flat side to a depth of 50 percent to 70 percent.

3. Pay Adjustment: Not applicable. Correct deficiencies at no additional cost to OWNER.

1.6 WEATHER

A. Temperature:

1. Apply seal coat when air and pavement surface temperatures in the shade are 70 deg F and rising.

2. Allow four (4) weeks of warm weather cure time. This generally limits performance of work from May 15 to August 31.

3. Do not apply seal coat if pavement surface is above 120 deg F.

B. Moisture and Wind: Do not apply seal coat during rain, if humidity prolongs curing, or in unsuitable windy weather.

1.7 NOTICE

A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying seal coat.

B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.

C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.

D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

E. Should work not occur on specified day, issue an updated notice advising when work will be performed.

PART 2 - PRODUCTS

2.1 BINDER

A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.

B. Emulsified Asphalt: Cationic or anionic emulsion, Section 32 12 03 “Asphalt Binders”. Use any of the following additives to match aggregate particle charge, weather conditions, and mix design:

1. Anti-strip: To change or neutralize particle charges.

2. Enhancer: To promote greater film thickness on the aggregate.

3. High Float Agent: To improve temperature susceptibility of the asphalt and impart a gel structure to the asphalt.

4. Polymer: To reduce stripping, improve coating, decrease temperature susceptibility and increase stability of mix.

5. Rejuvenator: To adjust penetration of base asphalt or soften reclaimed asphalt.

2.2 COVER AGGREGATE

A. Material: 100 percent crushed stone, slag or other high quality particle or combination. Clean and free from organic matter or other detrimental substances with the following properties.

Table 1 – Physical Properties

	Standard	Min	Max
Dry-unit weight (rodded), lb/ft^3	C 29	--	100
Wear (hardness or toughness), percent	C 131		30
Angularity (2 fractured or angular faces), percent	D 5821	60	--
Soundness (weight loss), percent	C 88	--	12

Polishing, BPN	D 3319	30	--
Flats or elongates (1:3 ratio), percent	D 4791	--	10
Friable particles, percent	C 142	--	3

NOTES:

1. Wear of aggregate retained on No. 8 sieve.
2. Soundness for combined coarse and fine aggregate measured using five (5) cycles Na_2SO_4.

B. Gradation: Analyzed on a dry weight and percent passing basis and graded as follows.

Table 2 – Master Grading Band

Sieve	Standard	Grade A	Grade B	Grade C
1/2 in.		100	–	100
3/8 in.		85 – 100	–	70 – 90
No. 4	C 136	0 – 20	–	0 – 5
No. 8		0 – 5	85 – 100	0 – 3
No. 16		–	10 – 25	–
No. 50		–	0 – 5	–
No. 200	C 117	0 – 1	0 – 2	0 – 2

NOTES:

1. Portion retained on No. 4 sieve clean and free of clay coatings.
2. Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum.
3. Portion passing No. 200 sieve includes mineral filler, ASTM C117.

2.3 MIX DESIGN

A. Select type and grade of emulsified asphalt, ASTM D3628.

B. Determine asphalt application rate based upon achieving an aggregate embedment of 50 to 70 percent.

C. Note: It is difficult to get adequate embedment of 3/8 inch aggregate with an asphalt application rate of 0.30 gallons per square yard.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Distributor Truck: Use triple overpass distributor bar setting. Apply asphalt binder uniformly (no drilling).

B. Aggregate Spreader: Variable width up to 20 feet in a single pass. Distribution varies no more than one (1) pound per yard.

C. Rollers: Rubber tire pneumatic with a gross load adjustable to apply 200 to 250 pounds per inch of rolling width.

3.2 PREPARATION

A. Equipment Calibration:

1. Do not begin or continue application without ENGINEER's knowledge of the calibration process and equipment settings.

2. Do not deviate from calibration settings without ENGINEER's knowledge.

B. Surface Repair: Method of payment to be determined by ENGINEER if any of the following repairs are required.

1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.

2. Providing tack coat on highly absorbent, polished, oxidized, or raveled bituminous pavement or on brick or Portland cement concrete surfaces.

3. Crack filling and crack sealing, Section 32 01 17 "Sealing Cracks in Bituminous Paving."

4. Pushing or shoving pavement to be repaired as follows.

a. Mill damaged area at least three (3) inches below required surface elevation. Section 32 01 16.71 "Cold Milling Bituminous Pavement."

b. Install and compact PG 64-22, DM-3/4, 50 blow bituminous concrete in lifts not less than three (3) inches after compaction. See additional requirements in Section 33 05 25 "Pavement Restoration."

C. Masking: Mask-off Street Fixtures, end of streets, intersections.

D. Traffic Control:

1. Implement traffic control plan requirements, Section 01 55 26 "Traffic Control." Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.

2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before applying seal coat. Unless specified otherwise, cost is included in the work of this section.

E. Cleaning:

1. Remove loose material, mud spots, sand, dust, oil, vegetation, and other objectionable material.

2. Do not flush water or apply pressurized water over cracked pavement unless ENGINEER allows its' use and a sufficient time is allowed for drying.

3.3 PROTECTION

A. Trees Plants, Ground Cover;

1. Protect trees, plants and other ground cover from damage.

2. Prune trees to allow equipment passage underneath, Section 32 01 93 “Pruning Trees.” Repair tree damage at no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalks guard rails, guide posts, etc. from physical damage.

3.4 APPLICATION

A. General: Wait at least seven (7) days before placing chip seal on new bituminous surfaces.

B. Asphalt Emulsion: Keep viscosity between 50 and 100 centistokes, ASTM D2170 during application.

1. Make straight lines along lip of gutter and shoulders, end of streets and in street intersections. No runoff onto these areas will be permitted.

2. Leave no holes, bare spots, or cracks.

3. Vary edge lines no more than one (1) inch per 100 feet.

4. Protect curb, gutter, and sidewalk from spatter, mar, or overcoat.

C. Chips: Apply aggregate within +1 to -2 pounds per square yard of mix design:

1. For polymer and latex modified emulsions, apply chips immediately.

2. For other emulsions, maintain a distance of not more than 100 feet between distributor and chip spreader.

3. Use a damp chip but not saturated. (Note. If water can be seen running out of the haul truck, the chips are too wet).

4. Spread larger aggregate first.

5. Hand broom cover material if necessary to distribute the aggregate uniformly over Pavement surface.

D. Blotting: If bleeding occurs, apply a blend of 25 to 50 percent hydrated lime with sand (blotting material). Use sand to cool chips.

3.5 ROLLING

A. Use a rubber tire roller to seat aggregate. Apply at least two (2) complete rolling coverage.

B. Complete rolling before the bituminous material cools or hardens.

C. Keep traffic off at least four (4) hours or until moisture leaves remaining chips. Sweep surface before allowing uncontrolled traffic on chips.

3.6 FOG SEAL

A. If a fog seal is specified, see Section 32 01 13.50 “Fog Seal.”

B. Apply within 24 hours of placing chips. Keep viscosity between 50 and 100 centistokes during application, ASTM D2170.

3.7 CAPE SEAL

A. If a cape seal is specified, remove loose chips (by sweeping), fog the chip seal surface with water, and apply slurry seal, Section 32 01 13.61 “Slurry Seal” within 48 hours of chip seal application.

3.8 FIELD QUALITY CONTROL

A. Emulsion density testing, ASTM D6937. If testing shows material non- compliance, halt operations, remove installed product and install new material known to be in compliance.

B. Measure the total amounts of material installed, and verify it meets the application rate.

3.9 AFTER APPLICATION

A. Raise reflective tabs that were covered over by application.

B. Clean Street Fixtures.

C. Do not apply permanent pavement markings or stripe material until layout and method of payment has been determined by ENGINEER and final application of seal coat has been in-place at least 14 days, or as permitted otherwise by ENGINEER. Layout must be verified by ENGINEER prior to application.

3.10 REPAIR

A. Remove non-compliant product found after installation and apply acceptable product.

B. Remove spatter, mar and overcoat from curb, gutter, sidewalk, guard rails, guide posts, etc.

C. Remove overcoat from Street Fixtures.

D. Make edge and end lines straight. Provide a good appearance.

E. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying Pavement.

F. Repair collateral damage caused by construction.

END OF SECTION

SECTION 32 01 13.68

HIGH DENSITY MINERAL BOND SEAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Application of an asphalt-aggregate *bond* seal coat as a high-density roadway surface preservation treatment.

1.2 REFERENCES

A. AASHTO Standards:

1. T59 Emulsified Asphalts.
2. T111 Mineral Matter or Ash in Asphalt Materials.

B. ANSI Standards:

1. B74.8 Ball Mill Test for Friability of Abrasive Grain.

C. ASTM Standards:

1. C128 Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
2. C170 Compressive Strength of Dimension Stone.
3. C1326 Knoop Indentation Hardness of Advanced Ceramics.
4. D1644 Nonvolatile Content (Solids by weight).
5. D2172 Quantitative Extraction of Bitumen From Bituminous Paving Mixtures.
6. D2196 Rheological Properties of Non-Newtonian materials by Rotational (Brookfield type) Viscometer.
7. D2486 Determining Wear Resistance in Cycles.
8. D2939 Emulsified Bitumens Used as Protective Coatings.
9. D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
10. D3960 Determining Volatile Organic Compound Content of Paints and Related Coatings.
11. D6937 Density of Emulsified Asphalt.

12. E70 pH of Aqueous Solutions with the Glass Electrode.

1.3 SUBMITTALS

A. Mix Design: Provide the following. Allow ENGINEER 10 days to evaluate the submittal.

1. Date of mix design. If older than 60 days from date of submission, recertify mix design.

2. Proportions of aggregate, filler, water, polymer, and emulsion in the mix.

3. Residual in-place bitumen content, in pounds per square yard.

4. Residual in-place aggregate or mineral solids content, in pounds per square yard.

5. Thickness target for each application coat, in pounds per square yard.

6. Total minimum thickness, in pounds per square yard.

7. Results of a wear resistance test current within one (1) calendar year (this section article 2.3).

B. Before Placement: Submit at least 48 hours before delivery.

1. Traffic control plan, Section 01 55 26 “Traffic.”

2. List of construction equipment to be used.

3. Certificate from emulsion supplier stating emulsion meets requirements of this section.

4. Names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM standards.

5. Warranty.

C. Reports: If requested by ENGINEER, submit the following.

1. List of five (5) projects that have successful product applications on bituminous surfaces. Provide the names of whom to contact about each project.

2. Source and field quality control testing reports performed by CONTRACTOR and Suppliers.

1.4 QUALITY ASSURANCE

A. Foreman of CONTRACTOR’S crew or Supplier's representative has completed at least three (3) projects of similar scope. If crew foreman does not have such experience, Supplier must provide a full-time representative on site during application.

B. Use a laboratory that follows and complies with ASTM D3740 and Section 01 45 00 “Quality Control” requirements.

C. Verify mixture delivered to site contains the same emulsion specified in the mix design.

D. Do not change source of asphalt emulsion or aggregate without supporting changes in the mix design.

E. Reject product that does not meet requirements.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by Lot.

2. If non-complying material has been installed and no price for the material is specified, apply price adjustment against cost of work requiring complying material as part of its installation. See Section 01 29 00 “Payment Procedures.”

3. Dispute resolution, Section 01 35 10.

4. Opening surface treatment to vehicular traffic does not constitute acceptance.

5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. Asphalt Binder

1. Lot size is total contracted product placement. Sub-lot size is one day production.

2. Of all sub-lot samples collected, randomly select one and test it for physical properties in this section. The lot is acceptable if this single sub-lot test meets requirements. If the test does not meet requirements, continue testing other sub-lot samples for compliance.

3. Pay Reduction: At ENGINEER’s discretion, a lot with deficient sub-lot tests may be accepted if pay for the lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject.

C. Placement:

Pay Factor	Number of Non-complying Tests
1.00	0
0.95	1
0.90	2
0.85	3
Reject	4

1. Mat Appearance:

    a. No runoff onto concrete curbs, gutter pans, and shoulders.

    b. No streaking, drag marks or squeegee marks.

    c. No light spots.

    d. No de-bonding.

    e. Straight longitudinal edges with proper joints.

    f. Pay Reduction: Not applicable. Correct deficiencies at no additional cost to OWNER.

2. Mat thickness, bitumen content and aggregate content.

    a. Lot size is one (1) day production. Sub-lot size is 0.5 lane mile.

    b. Collect and test five (5) equally spaced samples from the initial sub-lot. Upon review of the initial sub-lot test results and at ENGINEER's discretion, acceptance of subsequent sub-lots may be based upon one or less samples from each subsequent sub-lot.

    c. Pay Adjustment: Not applicable. Correct deficiencies at no additional cost to OWNER.

1.6 WEATHER

A. Temperature:

1. Apply seal coat if air and pavement surface temperatures in the shade are 55 deg F and rising.

2. Cease application if air or pavement surface temperatures are likely to fall below 45 deg F within 48 hours.

B. Moisture and Wind:

1. Do not apply seal coat to a wet surface (no visible standing water or high sheen), during rain, 24 hours prior to forecast rain, or in unsuitable windy weather.

2. Cease work if humidity or other conditions prolong curing, or if wind conditions are unsuitable.

1.7 NOTICE

A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying seal coat.

B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.

C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.

D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

E. Should work not occur on specified day, issue an updated notice.

1.8 WARRANTY

A. Both the CONTRACTOR and Supplier shall provide a two (2) year minimum written warranty when the existing pavement is in an appropriate condition (CONTRACTOR and Supplier to determine condition). Warranty covers delaminating, peeling and pre-mature surface wear.

1. Before placement notify ENGINEER if pavement condition or application condition voids the warranty.

2. ENGINEER may allow or cancel product application at no cost to OWNER if warranty cannot be given.

B. After two (2) year period, acceptable performance is no delaminating, peeling, or inter-aggregate loss in surface wear. Mechanical disturbances by snow plow chatter, studded tires, etc. are excluded from warranty. Repair defective coverage at no additional cost to OWNER.

PART 2 - PRODUCTS

2.1 ASPHALT BINDER

A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17 “Sealing Cracks in Bituminous Paving.”

B. Tack Coat: SS or CSS grade, Section 32 12 13.13 “Tack Coat.” Use a tack coat that is compatible with seal coat application.

C. Emulsified Asphalt: Inorganic, non-ionic thixotropic mineral colloid at 77 deg C that meets the following requirements. Inorganic is defined as a non-carbon based emulsifier.

Table 1 – Emulsion Properties

	Standard	Min	Max
Brookfield Viscosity at 77 deg F (Spindle 5, 20 rpm), cPs	D2196	11,000	20,000
pH	E70	5.0	7.5
Density, lbs/gal	T59	8.5	9.0
Solids, percent by weight	D2939	50	54
Asphalt cement content, percent by weight	D2172	45	50
Solids content, percent by weight	T59	50	54

Ash content, percent by weight	T111	4.0	6.0

2.2 AGGREGATE

A. Clean and free from organic matter or other detrimental substances. Composed of clay, corundum, slate, sand or other round particles meeting the following properties.

Table 2 – Aggregate Properties

	Min	Max
Bentonite and attapulgite clay, percent		1.8
Refined corundum and slate content, percent	34.5	
Sand or other round aggregate, percent		6

NOTES:

1) Corundum Properties:
   Specific gravity is 3.9 minimum (ASTM C128)
   Knoop 100 hardness is 2,000 minimum (ASTM C1326)
   Ball mill friability (14 grit) is 50 maximum (ANSI B74.8)

2) Slate Properties:
   Specific gravity is 2.7 maximum (ASTM C128)
   Compressive strength is 11,000 minimum (ASTM C170)

2.3 ADDITIVES

A. Water is clean, non-detrimental, and free from salts and contaminant.

B. Polymers and other additives as necessary to achieve mix design performance.

2.4 MIX DESIGN

A. Completed high density mineral bond material, prior to being loaded for install, meets the following requirements.

Table 4 – Mix Properties

	Standard	Min	Max
Asphalt content, percent by weight	D2172	17	20
Solids content, percent by weight	D1644	55	63
Initial Brookfield viscosity at 77 deg. F, (Spindle 4, 20 rpm), cPs	D2196	5,500	9,000
Ash content, percent by weight	T111	38	--
Ash content of solids, percent by weight(a)	T111	65	--
Density, lbs/gal	T59	11	--

pH	E70	6.0	8.0
Total inorganic aggregate content, percent by weight(b)	T111	37	--
Total sand content, percent by weight	--	--	6.0
Maximum VOC, g/L	D3960	--	5
Resistance to re-emulsification	D2939	None	
Wear resistance, percent loss by weight(c)	D2486	--	4

NOTES:

1) Ash content as a percentage of solids content.
2) Ash content of completed mix minus ash content of base non-ionic emulsion. Total inorganic aggregate content is defined as slate, refined corundum, and sand.
3) ASTM D2486 (Modified): Prepare sample at 48 wet mils on glass panel. Dry at 77 deg F for three (3) days. Immerse in water for 24 hours at 77 deg F. Test scrub resistance with 1,000 gram brass brush for 12,000 cycles. Report percent of dry film lost.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Paver: Use a continuous flow mixing unit.

1. Capable of applying at least 15,000 square yards of material per day.
2. Equipped with full sweep agitation system to assure proper suspension of fine aggregates.
3. Equipped with an operator control station that adjusts material spread rate in accordance with project calibration process.
4. Equipped with a filtering system to catch particles that plug nozzles.
5. Equipped with a retractable spray bar capable of applying mixture without drilling. The bar should be positioned to meet calibration requirements.

B. Storage Tanks:

1. When delivering mix from the central mixing plant to a job site storage tank, use only storage tanks with a capacity to contain the entire transport load.
2. Ensure that all site storage tanks have internal full sweep mixing mechanisms and mixing capability that can provide at any given point in the tank a homogenous mix.

3.2 PREPARATION

A. Paver Calibration: On a test strip at least 300 feet long, determine the correct pump settings, spray bar height, and ground speed for the application equipment. Apply material with pump settings at 80 percent of maximum output (plus or minus 5 percent) and a ground speed of 300 to 400 feet per minute.

1. Do not begin or continue application without ENGINEER's knowledge of the calibration process and equipment settings.

2. Do not deviate from calibration settings without ENGINEER's knowledge.

B. Surface Repair: Method of payment to be determined by ENGINEER if any of the following repairs are required.

1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.

2. Providing tack coat on highly absorbent, polished, oxidized, or raveled bituminous surfaces or on brick and concrete surfaces.

3. Crack filling and crack sealing, Section 32 01 17 "Sealing Cracks in Bituminous Paving."

4. Pushing or shoving pavement to be repaired as follows.

a. Mill damaged area at least three (3) inches below required surface elevation, Section 32 01 16.71 "Cold Milling Bituminous Pavement."

b. Install and compact PG64-22, DM-3/4, 50 blow bituminous concrete in lifts not less than three (3) inches after compaction. See additional requirements in Section 33 05 25 "Pavement Restoration."

C. Masking: Mask-off Street Fixtures, end of street intersections.

D. Traffic control:

1. Implement traffic control plan requirements, Section 01 55 26 "Traffic Control." Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.

2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before applying seal coat. Unless specified otherwise, cost is included in the work of this section.

E. Cleaning:

1. Remove loose material that may cause drag marks.

2. Remove mud spots, sand, dust, oil, vegetation and other objectionable material.

3. Do not flush water or apply pressurized water over cracked pavement unless ENGINEER allows its' use and a sufficient time is allowed for drying.

3.3 PROTECTION

A. Trees, Plants, Ground Cover:

1. Protect trees, plants, and other ground cover from damage.

2. Prune trees to allow equipment passage underneath, Section 32 01 93 “Pruning Trees.” Repair tree damage at no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalks, guard rails, guide posts, etc. from physical damage.

3.4 APPLICATION

A. General: Two separate application coats are required. The first application must be thoroughly set and free of any damp areas before the second application begins.

B. Spreading:

1. Keep material delivery at a constant rate even if the forward speed of lay-down machine varies.

2. Do not reduce application rate along edges or around manhole covers.

3. Apply both applications right to the edge of the pavement. Do not leave uncovered areas near curbs, Street Fixtures, or edges on either application.

4. Make straight lines at all locations.

5. Place product out to right-of-way line on side streets and intersections.

6. Use had squeegees to spread mix in areas that cannot be reached with distribution spray bar.

a. Provide complete and uniform coverage.

b. Avoid unsightly appearance from hand work.

C. Joints:

1. Make transverse joints straight-cut butt type, not over-lap type.

2. Place longitudinal joints on lane lines. Limit overlap to three (3) inches maximum.

3. Stop and correct paving operation if longitudinal or transverse joints have uncovered areas or unsightly appearance.

D. Lines:

1. Make straight lines along lip of gutters, shoulders, end of streets, and in street intersections. No runoff on these areas will be permitted.

2. Vary edge lines no more than one (1) inch per 100 feet.

3.5 TOLERANCES

A. First application = 0.20 gallons per square yard minimum.

B. Second application = 0.16 gallons per square yard minimum.

3.6 FIELD QUALITY CONTROL

A. Emulsion density testing, ASTM D6937. If testing shows material non- compliance, remove installed product and halt operations until new material is delivered and is known to be in compliance.

B. Measure the total amounts of material installed, and verify it meets the application rate.

3.7 AFTER APPLICATION

A. Raise reflective tabs that were covered over by application.

B. Clean Street Fixtures.

C. Do not apply permanent pavement markings or striping material until layout and method of payment has been determined by ENGINEER, and final application of seal coat has been in place at least 10 days, or as permitted by ENGINEER. Layout must be verified by ENGINEER prior to application.

3.8 REPAIR

A. Remove delaminated or non-compliant product found after installation and apply acceptable product.

B. Remove spatter, mar and overcoat from curb, gutter, sidewalk, guard rails, guide posts, etc.

C. Remove overcoat from Street Fixtures.

D. Make edge and end lines straight. Provide a good appearance.

E. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.

F. Repair collateral damage caused by construction.

3.9 OPENING TO TRAFFIC

A. Cure time depends on type of asphalt, mixture characteristics and weather. Keep traffic off of surface until material does not track-out.

END OF SECTION

SECTION 32 01 13.69

MICRO-SURFACE SEAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stone and an asphalt binder slurry evenly mixed and spread in variably thick cross sections as a seal coat for roadways and thoroughfares.

1.2 REFERENCES

A. ASTM Standards:

1. C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
2. C117 Amount of Material Finer Than 0.075 mm Sieve in Aggregate.
3. C131 Resistance to Degradation of Small-Size coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
4. C136 Sieve Analysis of Fine and Coarse Aggregates.
5. C142 Clay Lumps and Friable Particles in Aggregates.
6. D5 Penetration of Bituminous Materials.
7. D36 Softening Point of Bitumen (Ring-and-Ball Apparatus).
8. D242 Mineral Filler for Bituminous Paving Mixtures.
9. D244 Emulsified Asphalts
10. D1664 Coating and Stripping of Bitumen-Aggregate Mixtures.
11. D2170 Kinematic Viscosity of Asphalts (Bitumens).
12. D2419 Sand Equivalent Value of Soils and Fine Aggregate.
13. D3319 Accelerated Polishing of Aggregates Using the British Wheel.
14. D3628 Selection and Use of Emulsified Asphalts.
15. D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
16. D3910 Design, Testing, and Construction of Slurry Seal.
17. D4791 Flat or Elongated Particles in Coarse Aggregate.
18. D5821 Determining the percentage of Fractured Particles in Coarse Aggregate.

1.3 SUBMITTALS

A. Mix design. Provide the following. Allow ENGINEER 10 days to evaluate the submittal.

1. Date of mix design. If older than 365 days from date of submission, recertify mix design.

2. Target Grading Curve for aggregate.

3. Percentages of emulsion, aggregate, water and additives in the mix.

4. Emulsion type and time target for opening up a thoroughfare to traffic.

5. Results of asphalt stripping test and wet track abrasion test.

6. Type and minimum amount of polymer solids to be incorporated in the asphalt emulsion by the Supplier. (in general, three (3) percent based on asphalt weight is considered minimum).

7. Identity of additives added to the emulsion mix or to any of the component materials for control of the quick traffic properties.

8. Slurry application rate.

9. Aggregate physical properties (this section article 2.2). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than 365 days from date of submission.

B. Before Placement: Submit at least 48 hours before delivery:

1. Traffic control plan, Section 01 55 26 “Traffic Control.”

2. List of the construction equipment to be used.

3. Aggregate hardness, soundness and polishing test results (this section article 2.2). Aggregate analysis to be no more than 180 days old.

4. Meter settings for micro-surfacing machine. Previously determined settings for the meters may be submitted providing such determinations are no more than 180 days old and the materials used in such determinations match those specified herein.

5. Test results of five (5) day settlement test, ASTM D244 on emulsions stockpiled longer than 36 hours by CONTRACTOR. This submittal may be waived, providing the CONTRACTOR’s storage unit has continuous mixing capability, or the emulsion has had additional emulsion blended into it before use.

6. Certificate by emulsion supplier identifying:

a. the mix design for which the emulsion is formulated.

b. the emulsion meets requirements of this section article 2.1.

c. the type of polymer modifier added to the emulsion.

d. the amount of polymer modifier added to the emulsion.

7. Asphalt Bill of Lading: Identify weight of asphalt, weight of emulsified asphalt (after water has been added and that Asphalt Binder complies with Section 32 12 03 “Asphalt Binders” requirements).

C. Reports: If requested by ENGINEER, submit report of source and field quality control testing performed by CONTRACTOR and Suppliers.

1.4 QUALITY ASSURANCE

A. Foreman of CONTRACTOR’s crew has completed at least three (3) projects of similar scope.

B. Use a laboratory that follows and complies with ASTM D3740 and Section 01 45 00 “Quality Control” requirements.

C. Verify asphalt emulsion delivered to site is the same emulsion specified in the mix design.

D. Do not change source of asphalt emulsion or aggregate without supporting changes in the mix design.

E. Reject product that does not meet requirements.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by Lot.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring seal coat material as part of its installation. Section 01 29 00 “Payment Procedures.”

3. Dispute resolution, Section 01 35 10.

4. Opening new seal coat to traffic does not constitute acceptance.

5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. Mix Design: Use the following as a guide in evaluating the mix design.

1. Residual Asphalt: 5.5 to 10.5 percent by dry weight of aggregate.

2. Mineral Filler: 0 to 3 percent by dry weight of aggregate.

3. Polymer Based Modifier: Less than 3 percent solids based on bitumen weight content.

4. Sand Equivalency: Control of set time.

C. Asphalt Binder:

1. Lot size is total contracted material placement. Sub-lot size is one day production.

2. Of all sub-lot samples collected, randomly select one sub-lot and test it for the physical properties in this section. The lot is acceptable if tests on this sub-lot sample meets requirements. If the sample does not meet requirements, continue testing other samples for a sample that complies.

3. Pay Reduction: At ENGINEER's discretion, a lot with a deficient sub-lot tests may be accepted if pay for the lot is reduced using one of the following applicable pay factors, or lot may be accepted at 50 percent pay if lot is in Reject.

Pay Factor	Number of Non-complying Tests
1.00	0
0.95	1
0.90	2
0.85	3
Reject	4

D. Aggregate:

1. Lot size is one (1) day production with 500 tons sub-lots.

2. Collect samples randomly from mixing equipment and test gradation, ASTM C136. Lot will be acceptable if:

a. Average gradation of each sieve for the lot is within Target Grading Band for that sieve, and

b. Number of Samples in lot with any sieve measurement outside of Target Grading Band does not exceed two (2), and

c. No sample varies from Target Grading Band by more than target tolerance on any one (1) sieve.

3. Price Adjustment: Aggregate gradation defects may be accepted if a 2.5 percent price reduction is applied against the Lot for each condition not met. Maximum price reduction for the Lot is five (5) percent.

E. Mat Appearance: Correct deficiencies at no cost to OWNER.

1. No runoff onto concrete curbs, gutter pans, and shoulders.

2. No streaking, drag marks or squeegee marks.

3. No light spots.

4. No de-bonding.

5. Straight longitudinal edges with proper joints.

1.6 WEATHER

A. Temperature:

1. Apply seal coat when air and pavement surface temperatures in the shade are 45 deg F and rising.

2. Do not apply seal coat if air or pavement surface is below 55 deg F and falling or if the finished product will freeze before 24 hours.

B. Moisture and Wind: Do not apply seal coat to a wet surface, (no visible standing water or high sheen), during rain, if humidity prolongs curing, or in unsuitable windy weather.

1.7 NOTICE

A. Follow Laws and Regulations concerning when and to whom notices are to be given at least three (3) days before applying new seal coat.

B. Indicate application time and when new surface can be used. If necessary, include a map showing closed-off areas.

C. Provide phone numbers of at least two (2) individuals who represent the CONTRACTOR who can be reached at any time during the work.

D. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

E. Should work not occur on specified day, issue an updated notice advising when work will be performed.

PART 2 - PRODUCTS

2.1 ASPHALT BINDER

A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour, Section 32 01 17.

B. Tack Coat: SS-1 or CSS-1, Section 32 12 13.13 “Tack Coat.” Use a tack coat that is compatible with seal coat application.

C. Emulsified asphalt: CSS-1h quick-traffic type, ASTM D3628 with a two hour return to traffic quickset. The use of polymer solids is CONTRACTOR’s choice.

Table 1 – Asphalt Binder Properties				
	Standard	**Target**	**Min**	**Max**

Tests on emulsion				
Viscosity at 25 deg C, SSF	D244	32	15	90
Sieve test, percent	D244	0.01	--	0.30
Settlement, 5 day, percent	D244	3.5	--	5
Storage stability, 1 day, percent	D244	0.6	--	1
Residue by distillation	D244	64.2	62	--
Tests on residue from evaporation				
Penetration at 25 deg C, 0.1mm	D140	51	40	90
Softening point, deg C	D36	60	57	--
Kinematic viscosity, cSt/sec	D2170	--	650	--
Saybolt furol viscosity at 77 deg F, cSt/sec	D2170	--	--	50
Polymer solids based on mass of residual asphalt, percent	--	3 to 6	3	--

NOTES:

1) Cement mixing test waived.
2) Polymer solids are to be milled or blended into the asphalt or emulsifier solution before the emulsification process.

2.2 AGGREGATE

A. Material:

1. Clean and free from organic matter or other detrimental substances.

2. Stone, slag or other high quality particle or combination, 100 percent crushed with the following physical properties.

Table 2 – Aggregate Properties

		Standard	Max	Min
Angularity (fractured faces), percent		D5821	80	--
Wear (hardness or toughness), percent		C131	--	30
Soundness (weight loss in 5 cycles), percent	Na2SO4	C88	--	15
	Mg2SO4	C88	--	25
Clay content (sand equivalent), percent		D2419	65	--
Polishing, BPN		D3319	35	--

NOTES:

1) Angularity of aggregate retained on No. 4 sieve with at least one (1) mechanically fractured face or clean angular face.
2) Wear of aggregate retained on No. 8 sieve.
3) Soundness for combined coarse and fine aggregate.
4) Clay content before additives.

B. Gradation: Analyzed by ASTM C136 on a dry weight and percent passing basis:

1. Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum.

2. For heavy-duty surface applications use 100 percent crushed material.

3. Target Grading Curve must lie within one of the following Master Grading Bands. Field Samples shall not vary from the Target Grading Curve by more than the target tolerance.

Table 3 – Master Grading Band and Target Tolerance Limits

Sieve	Master Grading Band		Target Tolerance
	Type II	Type III	
1/2 in.	–	100	–
3/8 in.	100	>85	+/- 5
No. 4	70 – 90	60 – 87	+/- 5
No. 8	45 – 70	40 – 60	+/- 5
No. 16	28 – 50	28 – 45	+/- 5
No. 30	19 – 34	19 – 34	+/- 5
No. 50	12 – 25	12 – 25	+/- 4
No. 100	7 – 18	7 – 18	+/- 3
No. 200	5 – 15	4 – 8	+/- 2

NOTES:

1) Target tolerances is the allowable variation from the Target Grading Curve.
2) Portion retained on No. 4 sieve.
   a) clean and free of clay coatings
   b) more than 80 percent of the particles by weight, with at least 1 mechanically fractured face or clean angular face
3) Portion passing No. 200 sieve includes mineral filler, ASTM C117

2.3 ADDITIVES

A. Use water that is clean, non-detrimental, free from salts and contaminant.

B. Mineral filler, ASTM D242.

C. Portland cement, hydrated lime, limestone dust, fly ash, or aluminum sulfate to regulate setting time and improve workability.

D. Limestone dust, fly ash, and rock dust to alter aggregate gradation.

2.4 MIX DESIGN

A. Proportioning: Using procedures for mix design developed by the International Slurry Surfacing Association, determine the proportions of aggregate, mineral filler (minimum and maximum), water (minimum and maximum), polymer modified asphalt emulsion, and additives in the mix.

B. Set and Cure Time: Select to meet opening to traffic requirements.

C. Striping: More than 90 percent of bituminous-coated particles retain asphalt coating, ASTM D1664.

D. Wet Track Abrasion: ASTM D3910.

1. 50 grams per square foot maximum in a one (1) hour soak, and

2. 75 grams per square foot maximum in a six (6) day soak.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Mixing Equipment: Use a storage and mixing device capable of accurately proportioning and delivering aggregate, emulsified asphalt, mineral filler, additive, and water on a continuous flow basis to a spreader box. Mixing equipment must perform as follows.

1. Capable of applying at least 15,000 square yards per day.

2. Equipped with proportioning devices based upon either volume or weight control.

3. Its' mixer is to be a multi-blade, multi-shaft unit:

a. Autonomous if lay-downs are longer than 600 feet.

b. Truck mounted is permitted for lay-downs less than 600 feet.

B. Spreader:

1. Equipped with a spreader box that has a front seal so no loss of mixture occurs at road contact and an adjustable rear seal to act as a final strike-off device.

2. Equipped with a secondary strike-off device to improve surface texture.

C. Rut Filling Box: Wide enough to bridge ruts.

3.2 PREPARATION

A. Meter Calibration: On a test strip at least 500 feet long, determine the correct meter settings on the mixing equipment. Settings are to produce a product that complies with the following:

1. Thirty (30) minutes maximum initial set time. Initial set occurs when blotting of the seal coat yields only water (no emulsion).

2. No distress when exposed to traffic two (2) hours after placement.

B. Surface Repair: Method of payment to be determined by ENGINEER if any of the following are required.

1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.

2. Providing tack coat on highly absorbent, polished, oxidized, or raveled bituminous pavement or on brick or portland cement concrete surfaces.

3. Crack filling and crack sealing, Section 32 01 17 “Sealing Cracks in Bituminous Paving.”

4. Pushing or shoving pavement to be repaired as follows.

a. Mill damaged area at least three (3) inches below required surface elevation, Section 32 01 16.71 “Cold Milling Bituminous Pavement.”

b. Install and compact PG64-22, DM-3/4, 50 blow bituminous concrete in lifts not less than three (3) inches after compaction. See additional requirements in Section 33 05 25 “Pavement Restoration.”

C. Masking: Mask-off Street Fixtures, end of street, and intersections.

D. Traffic Control:

1. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control Plan.” Provide safe passage for pedestrians and vehicles. Do not proceed without flaggers if work requires maintaining two-way vehicular traffic.

2. Grind off existing pavement markings and lane stripes. If existing markings and stripes are to be reestablished, use reflective tabs to mark existing locations before applying seal coat. Unless specified otherwise, cost of this work is included in the work of this section.

E. Cleaning:

1. Remove loose material, mud spots, sand, dust, oil, vegetation, and other objectionable material.

2. Do not flush water, or apply pressurized water over cracked pavement unless ENGINEER allows its' use and a sufficient time is allowed for drying.

3.3 PROTECTION

A. Trees, Plants, Ground Cover.

1. Protect trees, plants, and other ground cover from damage.

2. Prune trees to allow equipment passage underneath, Section 32 01 93 “Pruning Trees.” Repair tree damage at no additional cost to OWNER.

B. Protect structures, curb, gutter, sidewalk, guard rails, guide posts, etc. from physical damage.

3.4 SPOT LEVELING

A. Where rut deformation is less than 1/2 inch apply only amount of seal coat needed to level the surface (scratch course).

B. Where rut deformation exceeds 1/2 inch:

C. Mill high spots.

D. Use a rut-filling box.

E. Use multiple placements when ruts depth exceeds 1-1/2 inches. For every inch of seal coat add 1/8th to 1/4 of an inch of material as a crown (allows for compaction under traffic).

F. Allow three (3) days cure time under traffic.

3.5 APPLICATION

A. General:

1. Machine meter settings must match mix design.

2. Pre-wet existing pavement surface to prevent premature breaking or to improve bonding.

3. Wait at least two (2) hours if an adjacent pass has broken and started to cure.

4. When cured, the seal coat shall present a uniform, skid-resistant appearance with all cracks filled.

B. Additives: During application, water and additives may be increased or decreased (per mix design) for better consistency or set time.

C. In the Spreader Box:

1. No spreading of material remaining in box when mixer is shut off.

2. No additional water added to the box.

3. No lumping, balling or unmixed aggregate.

4. No segregation of the emulsion and aggregate fines from the coarse aggregate.

5. No breaking of emulsion.

6. No overloading. Carry a sufficient amount of seal coat in all parts of the spreader for complete coverage.

D. Spreading:

1. Dampen surface immediately before seal coat application. All surfaces are to be uniformly damp with no free water standing on the surface or in cracks when seal coat is applied.

2. If coarse aggregate settles to bottom of mix, remove seal coat from pavement.

3. Butt joint adjacent lanes at edges and provide complete sealing at joint.

4. In areas where spreader box cannot be used, apply seal coat by hand.

E. Joints:

1. Make transverse joints straight-cut butt type, not over-lap type.

2. Place longitudinal joints on lane lines. Limit overlap to three (3) inches maximum.

3. Tolerance for joint match is 1/4 inch difference in elevation when measured with a 10 feet long straight edge over the joint.

4. Stop and correct paving operation if longitudinal or transverse joints have uncovered areas or unsightly appearance.

F. Lines:

1. Make straight lines along lip of gutter and shoulders. No runoff on these areas will be permitted. Remove if happens.

2. Vary edge lines no more than two (2) inches per 100 feet.

3.6 TOLERANCES

A. Type II aggregate thickness = 16 to 18 pounds per square yard.

B. Type III aggregate thickness = 20 to 25 pounds per square yard.

3.7 FIELD QUALITY CONTROL

A. If an ASTM C136 sieve analysis shows aggregate gradation non- compliant, either remove the material or blend in other aggregates to bring it into compliance. This may require a new mix design. Screening may be required at the stockpile to remove any defective materials.

B. Measure total amounts of material installed, and verify it meets the application rate.

3.8 AFTER APPLICATION

A. Raise reflective tabs that were covered over by application.

B. Clean Street Fixtures.

C. Do not apply pavement markings or stripe materials until layout and method of payment has been determined by ENGINEER and final application of seal coat has been in-place at least 14 days, or as permitted by ENGINEER. Layout must be verified by ENGINEER prior to marking applications.

D. If coarse aggregate settles to the bottom of the mix, remove and replace the application. When cured, the application shall be uniform and skid- resistant.

3.9 REPAIR

A. Remove spatter, mar, and overcoat from curb and gutter, sidewalk, guard rails and guide posts, etc.

B. Remove overcoat from Street Fixtures.

C. Make edge and end lines straight. Provide a good appearance.

D. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.

E. Repair collateral damage caused by construction.

3.10 OPENING TO TRAFFIC

A. Cure time depends on type of asphalt, mixture characteristics, and weather. Keep traffic off of surface until seal coat material does not track-out.

END OF SECTION

SECTION 32 01 16.71

COLD MILLING BITUMINOUS PAVEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lower surface elevation of bituminous concrete Pavement by milling.

2. If grinding is required to smooth-out surface bumps or depressions refer to Section 32 01 26 “Grinding Pavement.”

1.2 REFERENCES

A. APWA (Utah) Standards:

1. Plan 253 Bituminous concrete pavement overlay.

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26 “Traffic Control.”

B. Arborist’s certification.

C. Pre-milling profilographs for full width mills.

D. Redline drawings showing discovered existing utilities.

1.4 QUALITY ASSURANCE

A. Provide a person capable of calculating grades and cross-slopes in degrees and percentages. Cross slopes vary when the crown line is not parallel to pavement edge line.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PAYMENT PROCEDURES

A. No payment for leveling course to correct over milling or for additional milling to correct shallow milling.

1.7 SITE CONDITIONS

A. Existing Street Fixtures may have been paved over making them hidden (or buried). Locate and protect them. Failure to find them may result in damage to milling equipment. Repair damaged CONTRACTOR machinery and Street Fixtures at no cost to OWNER.

PART 2 – PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Detector: Able to find Street Fixtures (utility frames and covers, valve boxes, etc.) that are buried under pavement surface.

B. Milling Machine:

1. Equipped to prevent air pollution.

2. Equipped with a system to control depth and slope of mill cut.

C. Cleaning equipment able to pick up millings and waste water.

3.2 PREPARATION

A. Notify neighborhood at least 48 hours before day and time of milling.

B. Coordinate utility locations, Section 01 31 13. Preserve all active utilities.

C. Implement traffic control plan requirements in Section 01 55 26 “Traffic Control.”

D. Mark areas in the field that are to be milled. Mark existing utilities on redline drawings.

E. Use a detector to find hidden (or buried) Street Fixtures.

3.3 PROTECTION

A. Install Invert Covers, Section 01 71 13.

B. Lower utility frames, covers, and other Street Fixtures.

C. Trees may require pruning, Section 32 01 93 “Pruning Trees.” Avoid or minimize damage to tree branches. Provide certified arborist observation of tree branch cuts larger than four (4) inches diameter. Notify ENGINEER of such tree branch cut or damage.

D. CONTRACTOR is liable for any property damage due to loose material on pavement surface, vertical pavement cuts, drop-offs, etc.

E. Protect plant and animal habitat. Follow federal, state or local work permit requirements.

3.4 MILLING

A. If not indicated elsewhere meet cross slopes and depth of milling shown on APWA Plan 253.

B. Meet profile grade required or indicated by ENGINEER.

C. Do not disfigure adjacent work or existing surface improvements by accidentally cutting into them. Make appropriate repairs.

D. If milling exposes smooth underlying pavement surface, mill the smooth surface to make it rough.

E. Mill off additional material if standing water has a potential to accumulate or if surface has been damaged by water since beginning of milling operation.

F. Where vehicles or pedestrians must pass over milled edges provide safe temporary ramps suitable to speed of user vehicles (or suitable for wheel chair user needs).

G. Unless stipulated elsewhere, all residues from the milling process become property and responsibility of CONTRACTOR. Waste millings legally. Do not discharge millings into storm drains, ditches, or waters of the State.

H. If work equipment is removed from the milling site and milled surface awaits further work, provide appropriate traffic control and cleaning.

I. Notify ENGINEER when milling exposes weak or unstable surfaces. Verify extent of exposure by proof rolling at no additional cost to OWNER.

3.5 TOLERANCES

A. Milling Depth: As indicated plus or minus 10 percent not uniformly high or uniformly low.

B. Striation Texture: Uniform, discontinuous, longitudinal, 3/16 inch deep maximum, 3/4 inch center to center.

C. Smoothness:

1. On Longitudinal Grade: Plus or minus 5/16 inch in 25 feet.

2. At Longitudinal Grade Breaks: Plus or minus 1/4 inch in 10 feet.

D. Cross Slope:

1. In the Parking Lane: Two (2) percent target, five (5) percent maximum.

2. In the Travel Lane: Two (2) percent target, 1.5 percent minimum.

3.6 FIELD QUALITY CONTROL

A. Edge Mill: Verify cross slopes. Advise ENGINEER if a two (2) percent maximum break-over angle on an edge mill indicated on APWA Plan 253 cannot be achieved.

B. Full Width Mill:

1. Verify cross slopes. Advise ENGINEER if a four (4) percent maximum break-over angle on a full width mill indicated on APWA Plan 253 cannot be achieved.

2. On thoroughfares exceeding 25 mph use laser profiling to determine depth of milling along the proposed crown line or other breakover point.

3. Verify cut depth calculations with ENGINEER before milling.

3.7 CLEANING

A. Unless indicated elsewhere, all residues from the milling process become property and responsibility of CONTRACTOR. Waste millings legally. Do not discharge millings into storm drains, ditches, or waters of the State. Legally dispose of milled material.

END OF SECTION

SECTION 32 01 16.74

IN-PLACE HOT REUSED BITUMINOUS PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seamless repair of bituminous concrete pavement by applying evenly distributed heat over the pavement surface, then mixing and compacting the heated pavement in-place.

1.2 REFERENCES

A. APWA (Utah) Standards:

B. Plan 254 Patch repair – in place hot reused bituminous paving.

1.3 SUBMITTALS

A. Manufacturer's product data, equipment and material specifications.

B. Traffic control plan, Section 01 55 26 "Traffic Control."

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PERFORMANCE REQUIREMENTS

A. Use a method that does not burn the pavement surface or burn off any existing bituminous pavement volatiles.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Rejuvenating agent, bituminous concrete mix, and reclaimed RAP or ROSP aggregate.

PART 3 - EXECUTION

3.1 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26.

B. Mark areas in the field that are to be repaired. Mark existing utilities on redline drawings.

C. Use a detector to find hidden (or buried) Street Fixtures.

3.2 REPAIRS

A. Apply heat to areas to be repaired:

1. Do not exceed a surface temperature of 350 deg F.

Minimum surface temperature is as indicated in Section 32 12 16.

B. Follow APWA Plan 254 requirements. Mechanically scarify and thoroughly mix the repair area. Provide beveled sides.

C. Add and thoroughly mix additional bituminous material and rejuvenating agent as required to fill depressions, Potholes, or to match grade of adjacent pavement surfaces.

D. Screed and level the repair area in preparation for compaction and allow the material to become integral with edges of repair area.

E. Compact surface with a steel drum roller. Match the grade of the adjacent pavement after compaction. No longitudinal surface bumps allowed.

F. Cool repaired area to 150 deg F before opening to vehicular traffic.

G. Reapply heat and rework area in the case where bumps and depressions are present in finished surface.

H. Sweep up and dispose of excess material and debris.

I. Repair any damage at no additional cost to OWNER.

END OF SECTION

SECTION 32 01 17

SEALING CRACKS IN BITUMINOUS PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Filling and sealing cracks in bituminous concrete pavements.

1.2 REFERENCES

A. APWA (Utah) Standards:

1. Plan 265 - Crack sealing.
2. Plan 266 - Crack filling.

B. ASTM Standards:

1. D 36 Softening Point of Bitumen (Ring-and Ball Apparatus).
2. D 977 Emulsified Asphalt.
3. D 1190 Concrete Joint Sealer, Hot-Poured Elastic Type.
4. D 2397 Cationic Emulsified Asphalt.
5. D 3381 Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
6. D 3405 Joint Sealants, Hot-Poured, For Concrete and Asphalt Pavements.
7. D 5078 Crack Filler for Asphalt Concrete and Portland Cement Concrete Pavements.
8. D 5329 Sealants and Fillers, Hot-Applied for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements.

1.3 SUBMITTALS

A. CONTRACTOR shall submit product data sheets and traffic control plan for approval.

1.4 QUALITY ASSURANCE

A. Do not use crack repair product that has been over-heated, suffered prolonged heating or ravels or can be pulled out by hand after placement.

B. Do not mix different manufacturer’s brands or different types of crack repair material.

C. Do not depress crack repair product temperature at the wand tip below the manufacturer's recommended application temperature when loading product into product tank.

D. Rework Defective Work.

E. Perform field tests to ensure proper adhesion and performance of the sealant materials.

F. CONTRACTOR must possess relevant certifications, licenses, and experience in crack sealing and filling.

1.5 ACCEPTANCE

A. Visually inspect areas for adhesion Failure, damage to crack repair product, missed cracks, foreign objects in the product, or other problems that indicate work is not acceptable.

1.6 DEFINITIONS

A. Crack Filling: The placement of materials into cracks to substantially reduce infiltration of water and to reinforce the adjacent Pavement. The crack receives no special preparation other than cleaning.

B. Crack Sealing: The placement of specialized materials in or above cracks to prevent the intrusion of incompressibles and water into the crack. The crack receives unique crack configuration preparation.

C. Pothole: Loss of surface material in a Pavement to the extent that a patch is necessary to restore Pavement ride quality.

D. Pavement: The surface material that is placed on a base course, such as asphalt or concrete, to provide a durable and smooth riding surface for vehicles.

1.7 NOTICE

A. Send written notice to residents and businesses within affected area at least three (3) days before application of Crack Filling or Crack Sealing material.

B. Indicate application time and when pavement surface can be used.

C. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

D. Should work not occur on the specified day, send a new notice.

1.8 WARRANTY

A. Provide a minimum of one-year warranty for all materials and workmanship associated with crack sealing and filling.

PART 2 - PRODUCTS

2.1 FILLER AND SEALER MATERIAL

A. Selection of Filler: Asphalt emulsion, unless specified otherwise.

B. Selection of Sealer: Hot applied asphalt rubber or hot applied rubberized asphalt, unless specified otherwise.

C. Thermoplastic products.

D. Environmentally-friendly materials:

E. Consider using eco-friendly alternatives for filler and sealer materials that have minimal environmental impact and adhere to local regulations.

Table 1 – Fillers and Sealers

Material Type	Standard	Application
Hot-applied		
Asphalt Rubber	D 5078	Sealing (possibly filling)
Rubberized Asphalt	D 1190 D 3405	Sealing
Low Modulus Rubberized Asphalt	(a)	Sealing
Asphalt Cement	D 3381	Filling
Mineral-filled Asphalt Cement (b)	D 3381	Filling
Fiberized Asphalt Cement (b)	D 3381	Filling
Chemically Cured		
Silicone	(c)	Sealing
Cold Applied		
Asphalt Emulsion	D 977 D 2397	Filling
Polymer-modified liquid asphalt	D 977 D 2397	Filling (possibly sealing)

NOTES:

1) ASTM D3405 or ASTM D5078 except as follows.
   a) Softening point, 85 deg. C. minimum, ASTM D36.
   b) Resilience: At least 30 percent recovery at 25 deg. C plus or minus 1 deg. C., ASTM D5329.
2) Additives such as mineral fillers and fibers provide minimal elasticity to asphalt and do not significantly affect temperature susceptibility.
3) Manufacturer's recommended specification.

PART 3 – EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Sealant Heating Equipment: Indirect heating using double boiler or circulating hot oil heat transfer for heating product. Do not use direct heat transfer units (tar pots). Unit must have means of constant agitation.

B. Hot Compressed Air Lance: Provide clean, oil-free compressed air at a volume of 100 cubic feet per minute at a pressure of 120 pounds per square inch.

3.2 PREPARATION

A. Allow at least one week for repaired cracks to cure and harden before placing thin overlays (chip seal, slurry seal, micro-surface, high density mineral bond, etc.).

B. Repair potholes full depth.

3.3 CRACK FILLING AND SEALING

A. Blow cracks clean. Remove foreign matter, loosened particles, and weeds.

B. Use a hot air lance when surfaces are wet or when air temperature is less than 40 deg F Do not burn the surrounding Pavement. Fill cracks immediately before cool down or reheat.

C. Crack fill: Provide Type A cap fill per APWA Plan 266, unless indicated otherwise.

D. Crack seal: Provide Type C backer rod seal per APWA Plan 265, unless indicated otherwise.

E. If a thin overlay is to be applied, remove crack overfill by squeegee.

3.4 PROTECTION

A. Place sand on surface of crack repair product if traffic or construction activities are likely to cause pull out. Replace pull out at no additional cost to OWNER.

B. Repair vehicles or other property damaged by crack repair operation.

3.5 SAFETY

A. Adhere to all relevant safety guidelines, regulations, and best practices during the execution of the project, including proper signage and traffic control measures.

B. Ensure that workers are properly trained and equipped with the necessary personal protective equipment (PPE).

3.6 CLEANUP

A. Remove all construction debris, surplus materials, and equipment from the site upon completion of the project.

B. Repair any damage caused to adjacent areas or structures during the execution of the project.

3.7 INSPECTION

A. Arrange for a final inspection by the relevant authorities or project owner to ensure that the work is completed in accordance with the specified requirements and standards.

END OF SECTION

SECTION 32 01 19

PATCHING RIGID PAVING

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Full depth removal and replacement of Portland cement concrete roadway pavement panels.

1.2 REFERENCES

A. APWA (Utah) Standards:

1. Plan 256 - Concrete pavement patch.

2. Plan 261 - Concrete pavement joints.

B. ASTM Standards:

1. A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcing.

2. C1315 Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

3. C150 Standard Specification for Portland Cement.

4. C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

5. C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

6. C94 Standard Specification for Ready-Mixed Concrete.

7. C143 Standard Test Method for Slump of Hydraulic-Cement Concrete.

8. C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.

9. C1315 Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

C. ACI Standards:

1. 318 (2019 or most current) Building Code Requirements for Structural Concrete.

2. 301 (2020 or most current) Specifications for Structural Concrete.

1.3 SUBMITTALS

A. Joint filler board data sheet.

B. Joint sealer data sheet.

C. Bond breaker data sheet.

D. Traffic control plan, Section 01 55 26 “Traffic Control.”

E. Concrete mix design.

F. Reinforcement details and layout.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Concrete compressive strength.

B. Profile and cross-section tolerance.

C. Reinforcement placement.

PART 2 – PRODUCTS

2.1 REINFORCEMENT

A. Reinforcement: Grade 60 ksi galvanized or epoxy coated steel; A775 and A767:

1. Dowel Bar: Smooth.
2. Tie Bar: Deformed.
3. Mat: Deformed.

B. Dowel Bar End Cap: Non-metallic that allows 1/4 inch longitudinal movement of bar.

2.2 CONCRETE

A. Class 4000 cast-in-place, Section 03 30 00 “Cast In Place Concrete.”

B. Slump range per mix design.

C. Aggregates conforming to ASTM C33.

D. Portland cement conforming to ASTM C150.

E. Admixtures approved by the ENGINEER.

2.3 ACCESSORIES

A. Bond Breaker: Paraffin wax, lithium grease, or other semi-solid, inert lubricant.

B. Expansion Joint Filler: F1 sheet 1/2 inch thick, Section 32 13 73 “Concrete Paving Joint Sealants.”

C. Contraction Joint Filler (Backer Rod): Closed cell, Type 1 round, Section 32 13 73 “Concrete Paving Joint Sealants.”

D. Contraction Joint Sealer: HAS1 or HAS4 hot applied, Section 32 13 73 “Concrete Paving Joint Sealants.”

E. Curing and Sealing Compound: Membrane type, ASTM C1315. Type II Class A or B (white pigmented).

F. Tackifier: Epoxy gel Type II, Section 03 61 00 “Cementitious Grouting” for attaching plastic concrete to existing hard concrete or for securing dowel and deformed tie bars in drilled holes.

G. Water Repellant: Penetrating compound, Section 07 19 00 “Water Repellant.”

H. Saw and diamond blade for cutting pavement, conforming to manufacturer's specifications.

2.4 SOURCE QUALITY CONTROL

A. Ready-mix concrete conforming to ASTM C94.

B. Concrete testing as per ASTM C143 and C138.

C. Use concrete accelerating admixtures in cold weather only when approved in the mix design. Use of admixtures will not relax cold weather placement requirements.

D. Use set retarding admixtures during hot weather only when approved by ENGINEER.

PART 3 – EXECUTION

3.1 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.”

B. Make full depth saw cuts around the perimeter of the rectangular section to be removed. Do not over cut.

C. Make full depth re-cuts along any edge that is damaged during repairs, including failures on the underneath of the slab caused by insufficient saw-cut depths.

D. Remove panels without damaging remaining panels. Use chains and lift pins.

E. Repair foundation materials, grade, and compact.

F. Repair concrete damaged by removal operations.

3.2 LAYOUT

A. Panels:

1. Follow APWA Plan 256 requirements.

2. Determine extent and dimensions of removal from Drawings, or provide acceptable removal plan to ENGINEER.

3. Form any side that does not have an adjacent panel. Form to match existing panels providing a vertical edge.

B. Joints:

1. Follow APWA Plan 261 requirements.

2. Tackifier required on vertical surface of cold joints, both transverse and horizontal. Do not apply bond breaker to cold joints.

3. Keep existing pavement joint layout when scoring.

4. Saw new concrete joint on same line if repairs straddle an existing joint line.

3.3 BAR PLACEMENT

A. Drill holes for bars using a rigid drill frame. Prevent bits from wandering.

B. Drill holes at mid-depth of the slab. Do not damage remaining pavement section. Remove contaminants from holes.

C. Deformed Bar: For drilled holes that receive deformed bars, place adhesive at far end of each hole. Fit retention ring to bar to prevent adhesive grout from flowing out of hole.

D. Dowel Bar: For drilled holes that receive smooth dowel bars, place grease at far end of drilled bar hole before insertion. Grease and place an expansion end cap on protruding end of dowel bars.

E. Repair any bar coating damage with appropriate repair material.

F. Repack loose bars prior to placing concrete mix.

G. Before placing concrete in the work area:

1. Allow firm set of adhesive grout around bar.

2. Coat dowel bar extension with bond breaker.

3.4 CONCRETE PLACEMENT

A. Section 03 30 10 “Concrete Placement.”

B. Make sure base course is uniformly damp at time of placement.

C. Prevent segregation of concrete mix.

D. Consolidate concrete along face of existing panels and under reinforcement. Keep vibrators away from joint assemblies and reinforcement. Do not dislocate reinforcement, dowels, and tie bars during consolidation.

3.5 FINISH

A. Section 03 35 00 “Concrete Finishing.”

B. Profile and cross-section tolerance is ± 1/8 inch.

C. Do not tool joints that are to be saw-cut and sealed.

D. Texture surface to match existing.

3.6 CURING

A. ASTM C1315. Apply total coverage in two (2) directions after texturing.

B. Eliminate thermal shock of concrete by keeping cure temperature even throughout extent and depth of concrete slab.

3.7 PROTECTION AND REPAIR

A. General: Protection and repair expenses are at no additional cost to OWNER.

B. Protection: Section 03 30 10 “Concrete Placement”:

1. Do not open to traffic until 4000 psi concrete strength is reached.

2. Protect concrete pavement surface against damage and marking. Place barricades at the proper locations to prevent traffic from using the pavement.

C. Repair:

1. Remove and replace any concrete slab replacement that exhibit cracking, shrinkage, or failure caused by traffic.

2. Correct patch profiles in excess of 1/8 inch higher or lower than the existing pavement profile through surface grinding or removal and replacement. Apply water repellant over surface grindings.

END OF SECTION

SECTION 32 01 20

DOWEL BAR RETROFIT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dowel bar assemblies across existing transverse joints and cracks in concrete roadway pavement slabs eight (8) inches thick or thicker.

2. Concrete patch.

1.2 REFERENCES

A. APWA (Utah) Standards:

1. Plan 262 Dowel bar retrofit.

B. ASTM Standards:

1. A615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcing.

2. C882 Bond Strength of Epoxy Resin Systems Used With Concrete By Slant Shear.

3. C1315 Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

1.3 SUBMITTALS

A. Sample of dowel bar and end cap.

B. Data sheets for:

1. Joint filler board.

2. Joint sealer.

3. Bond breaking compound on dowel bar.

4. Dowel bar epoxy or galvanizing coating.

C. Concrete mix design.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Concrete compressive strength, 03 30 05 “Concrete Testing.”

B. Field quality control by CONTRACTOR, this section article 3.2.

PART 2 - PRODUCTS

2.1 DOWEL BAR ASSEMBLIES

A. Dowel Bars:

1. Smooth, grade 60 ksi galvanized or epoxy coated steel, ASTM A775, and A767. Bars must be free from burrs or other deformations detrimental to free movement of the bars in the concrete. Bars must be sawn by manufacturer, not sheared.

2. White pigmented bond breaking curing compound or other semi- solid, insert lubricant applied at the manufacturing facility. DO NOT apply bond breaker while the dowel bar assembly is in the reservoir.

B. Chair Device: Non-metallic designed to press securely against the reservoir bottom and sides providing 1/2 inch clearance between reservoir bottom and bottom of bar.

C. End caps: Non-metallic that allow 1/4 inch bar movement required at both ends of bar.

2.2 CONCRETE PATCH

A. 3/8 inch aggregate maximum.

B. 3000 psi in 3 hours and 5000 psi in 24 hours, ASTM C109.

C. Shrinkage maximum in 4 days 0.13 percent, ASTM C157.

D. Bond strength of 1,000 psi in 24 hours, ASTM C882.

2.3 ACCESSORIES

A. Joint Products: Section 32 13 73 “Concrete Paving Joint Sealants.”

B. Curing and Sealing Compound: Membrane type, ASTM C1315.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Jackhammers: Less than nominal 30 pound class to prevent spalling.

B. Saws: Capable of cutting a minimum of three (3) slots simultaneously if more than 100 bars are to be placed in the Work. Less than 00, a walk behind saw may be used providing a template is used to ensure the slot locations are within the specified tolerances.

3.2 PREPARATION

A. Before the start of major operations, provide a test section consisting of at least 24 complete dowel bar retrofits.

B. In the presence of the ENGINEER and 24 hours after completing the test section randomly check dowel positioning by coring. Drill two cores, one on each end of a dowel bar to expose both ends and allow measurement for proper alignment. If the dowels are located incorrectly or air voids exist around the dowel bars, additional cores will be taken under ENGINEER's direction to determine severity.

C. CONTRACTOR will perform and patch all testing at no additional cost to OWNER.

D. Backfill all core locations using the acceptable dowel bar retrofit patching material.

3.3 INSTALLATION

A. Preparation: See APWA Plan 262 requirements.

B. Reservoir:

1. Saw, remove concrete, then sand blast. Remove dust, concrete slurry, and debris.

2. Skewed joints or cracks may require slots longer than the length shown in the plan. Increase length at no additional cost to OWNER.

3. If work is delayed for any reason reclean patching areas as necessary.

4. Apply CAS-5 silicone joint sealer to crack and joint in the reservoir walls and bottom.

C. Bars:

1. Place bars on chairs in middle of slab.

2. 1/2 inch clearance from bottom of reservoir.

3. Maximum allowable skew is 0.375 inches per 12 inches (3 percent) in horizontal and vertical planes.

D. Filler Board: Place in vertical plane of the transverse joint or crack. Fit tightly at reservoir bottom, sides and circumference of bar.

E. Concrete: Install and consolidate. Finish and apply curing and sealing compound.

F. After cure: Remove joint filler board across width of reservoir to a depth of two (2) inches. Seal joint with HAS-4 sheet, one component elastomeric type joint sealer.

3.4 PROTECTION AND REPAIR

A. General: All expenses are at no additional cost to OWNER.

B. Protection: Section 03 30 10 “Concrete Placement.” Protect downstream habitat from saw- cutting slurry.

C. Repair: Replace any non-functioning or damaged dowel bar retrofit.

END OF SECTION

SECTION 32 01 26

GRINDING PAVEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Smooth-out surface bumps or depressions in bituminous or Portland cement concrete Pavement by grinding.

2. If milling is required to lower a bituminous pavement surface refer to Section 32 01 16.71 “Cold Milling Bituminous Pavement.”

1.2 REFERENCES

A. ASTM E1155: Standard Test Method for Determining F F Floor Flatness and F L Floor Levelness Numbers.

B. ASTM E303: Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester.

C. ASTM D242: Standard Specification for Mineral Filler for Bituminous Paving Mixtures.

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26 “Traffic Control.”

B. Noise mitigation plan.

C. Public relations plan.

1.4 QUALITY ASSURANCE

A. Worker Experience: Provide a person capable of calculating grades and cross-slopes in degrees and percentages.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 SITE CONDITIONS

A. Existing Street Fixtures may have been paved over making them hidden (or buried). Locate and protect them. Failure to find them may result in damage to grinding equipment. Repair damaged machinery and Street Fixtures at no cost to OWNER.

PART 2 - PRODUCTS

2.1 GRINDING EQUIPMENT

A. Dust control system: Equipped with an effective dust suppression system.

B. Noise control measures: Comply with local noise regulations and minimize noise impact on surrounding areas.

C. Minimum production rate: Capable of achieving a minimum production rate of 3,000 square feet per hour.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Detector: Able to find Street Fixtures (utility frames and covers, valve boxes, etc.)

B. Roadway Grinding Machine: Self-propelled:

1. Cutting head 36 inches wide minimum.

2. 50 to 60 diamond blades per foot of head.

3. Equipped to prevent air pollution.

4. Equipped with a system to control depth and slope of grind cut.

C. Water truck, waste truck and cleaning equipment able to pick up grindings and wastewater.

3.2 PREPARATION

A. Notify neighborhood at least 48 hours before day and time of grinding.

B. Preserve all active utilities. Coordinate utility locations, Section 01 31 13.

C. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.”

D. Mark areas in the field that are to receive grinding.

E. Use a detector to find hidden (or buried) Street Fixtures.

F. Mark hidden and existing utilities on redline Drawings.

3.3 PROTECTION

A. Install Invert Covers, Section 01 71 13.

B. CONTRACTOR is liable for any property damage due to loose material on pavement surface, vertical pavement cuts, drop-offs, etc.

C. Protect transverse or longitudinal joints.

D. Avoid or minimize damage to tree branches. Provide certified arborist observation of tree branch cuts larger than four (4) inches diameter. Notify ENGINEER of such tree branch cut or damage.

E. Protect plant and animal habitat. Follow federal, state or local work permit requirements.

3.4 GRINDING

A. Grind until pavement on both sides of transverse joints and cracks is in the same plane and meets the same tolerance. Provide a smooth uniform finish texture.

B. Perform grinding in a longitudinal direction. Skid resistance of final ground surface must be comparable to adjacent sections not requiring corrective work.

C. Do not grind structures. Protect adjacent concrete flat work.

D. Surface treatment of grind areas as follows:

1. Bituminous Surface: Section 32 12 13.13 “Tack coat.”

2. Concrete Surface: Section 07 19 00 “Water Repellant.”

E. If work equipment is removed from the grinding site and grinding surface awaits further work, provide appropriate traffic control and cleaning.

F. Measure surface roughness according to ASTM E1155 after the grinding process is completed.

G. Maintain a consistent grinding pattern across the entire pavement surface, ensuring proper texture and uniformity.

3.5 TOLERANCES

A. Roadway Striation Texture: Uniform, continuous, longitudinal:

1. Groove width between 0.09 and 0.15 inches wide.

2. Peaks of ridges between grooves approximately 1/16 inch higher than the bottom of the grooves.

3. Width of peak ridges from 0.06 to 0.13 inches.

B. Smoothness: Required tolerances are indicated in Section 32 01 31 “Pavement Smoothness.”

1. No dent (or lip) at start or finish in longitudinal direction.

C. Cross Slope:

1. Uniform with no depressions or misalignment of slope greater than 1/4 inch in 10 feet between grade breaks (roadway crown line excepted).

2. 1/8 inch maximum dent (or lip) transverse to the direction of pedestrian or vehicle travel. Potential for standing water not allowed.

D. Taper lane grinding into shoulder (parking lane) area. Target is two (2) percent with a maximum allowable slope of five (5) percent.

E. Maximum grinding depth: Do not exceed a grinding depth of 1/4 inch unless otherwise approved by the ENGINEER.

3.6 CLEANING

A. All residues from the grinding process become property and responsibility of CONTRACTOR. Waste grindings legally. Do not discharge grindings into storm drains, ditches, or waters of the State.

END OF SECTION

SECTION 32 01 29

CONCRETE PAVING RAISING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Raise Portland cement concrete pavement and flat work to grade by jacking.

1.2 REFERENCES

A. ASTM Standards:

1. C150 Portland Cement.
2. C618 Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
3. C1107 Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
4. D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
5. D1621 Compressive Properties of Rigid Cellular Plastics.
6. D1622 Apparent Density of Rigid Cellular Plastics.
7. D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
8. D1621 Compressive Properties of Rigid Cellular Plastics.

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26 “Traffic Control.”

B. Plan for containing grout in the jacking process.

C. Data sheet for polyurethane or shrinkage resistant grout.

D. Procedure to be used in verifying injection fluid usage.

E. Injection sequence for raising roadway pavement panels.

F. Verify elevation of roadway pavement panel raising.

1.4 QUALITY ASSURANCE

A. Provide a licensed professional land surveyor to verify elevation changes in the roadway pavement profile.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PERFORMANCE REQUIREMENTS

A. Maintain at least 90% of initial pavement strength after raising operations.

B. Ensure minimal disturbance to adjacent pavements, utilities, and structures during raising operations.

C. Comply with all local, state, and federal environmental regulations during raising operations.

1.7 WARRANTY

A. Provide a minimum of 1-year warranty for the pavement raising work, covering any settling, shifting, or cracking due to the contractor's workmanship or materials.

PART 2 - PRODUCTS

2.1 POLYURETHANE

A. High density, water based formulation.

Table 1 – Physical Properties

	Standard	Min	Max
Density, lb/ ft^3	D1622	3.8	4.3
Tensile strength, psi	D790	100	--
Elongation, percent	--	5.1	--
Compressive strength at yield point, psi	D1621	90	--

NOTES:

1) Maximum time of set is 15 minutes.
2) Use value of flexural strength or flexural yield as tensile strength.

2.2 PORTLAND CEMENT GROUT

A. Type I or II, ASTM C150 with silica sand and a shrinkage-compensating agent with plasticizing and water reducing agents.

2.3 PORTLAND CEMENT DRY MIX

A. Select from the following options. Obtain ENGINEER's approval for any deviation from the option selected:

1. Option 1:

a. One volume Portland cement, type I or II, ASTM C1107.

b. Three volumes pozzolan, ASTM C618, type F.

c. Shrinkage compensating agent with plasticizing and water reducing agents.

d. Adjust water to meet field conditions.

2. Option 2:

a. One volume Portland cement, type I or II, ASTM C1107.

b. One volume pozzolan, ASTM C618, type F.

c. Two volumes clean sand.

d. Shrinkage compensating agent with plasticizing and water reducing agents.

e. Adjust water to meet field conditions.

2.4 GROUT INJECTION EQUIPMENT

A. Use injection equipment with pressure and flow control to ensure proper grout placement and prevent over-injection.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Pumping injection unit.

B. Drills and injection tubes.

C. Laser levels or dial micrometers.

D. Dynamic cone penetrometer.

E. Concrete saw.

F. Generators and other equipment.

3.2 PREPARATION

A. Pay applicable license or royalty fees.

B. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.”

C. Use professional land surveyor elevation measuring device to establish target profile grade for roadway panels.

3.3 PROTECTION

A. Protect down-stream fish habitat. Remove slurry deposits from surfaces.

B. Do not permit rain or sprinkler system water to wash away dust.

C. Contain injected material during the jacking process. If containment is lost, implement remediation procedures immediately.

D. Protect against displacement of adjacent surfaces.

3.4 ROADWAY PAVEMENT FOUNDATION STABILIZATION

A. Discover voids and soil conditions with penetrometer.

B. Limit concrete drill holes to 5/8 inch diameter maximum.

C. By injection, fill voids until pavement until lift is initiated.

3.5 JACKING

A. Saw-cut between failed and non-failed slabs as necessary to prevent damage to non-failed slabs.

B. Drill injection holes where necessary. Provide injection sequence for raising roadway pavement panels or concrete flat work without cracking. ENGINEER may order removal and replacement of panels cracked by CONTRACTOR at CONTRACTOR's cost.

C. Inject grout at proper depth to evenly raise pavement and flat work level with adjacent surface.

D. Do not displace adjacent surfaces.

E. After jacking, grade must be plus or minus 1/8 inch of target.

F. Fill injection holes with at least four (4) inches of non-shrink grout.

G. Patch drill holes.

3.6 REPAIR

A. Repair construction damage at no additional cost to OWNER. Damages include but are not limited to the following.

1. Raised adjacent slabs or structures not scheduled for rising.

2. Material or work product that shrinks, deteriorates, or otherwise fails by the end of the correction period.

3.7 QUALITY CONTROL AND INSPECTION

A. Verify proper grout injection volume and placement by monitoring injection pressures and quantities.

B. Inspect the raised pavement for uniformity, levelness, and compliance with specified tolerances.

C. Ensure proper bonding of grout to the existing pavement and foundation.

D. Conduct post-raising tests to verify the strength and stability of the raised pavement.

3.8 CLEANUP

A. Remove all excess grout, debris, and equipment from the site upon completion of the raising operations.

B. Restore the site to its original condition or better, ensuring that all surfaces are clean and free of any construction-related materials.

3.9 AS-BUILT DOCUMENTATION

A. Provide as-built documentation, including pre- and post-raising elevations, grout injection locations, and any deviations from the approved plan.

B. Submit the as-built documentation to the ENGINEER for review and approval upon completion of the work.

END OF SECTION

SECTION 32 01 31

PAVEMENT SMOOTHNESS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Smoothness tolerances for placing flexible pavements, rigid pavements, and pavement patches.

2. Procedure for correcting defective smoothness.

1.2 REFERENCES

A. ASTM Standards:

1. E950 Measuring the Longitudinal profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference

2. E1274 Measuring Pavement Roughness Using a Profilograph.

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26.

B. Certifications for profilographs, profilers, and operators.

C. Summary report of smoothness profile testing.

D. Photos and documentation of repaired areas.

1.4 QUALITY ASSURANCE

A. Provide testing equipment and a person capable of calculating grades and cross-slopes in degrees and percentages. Cross slopes vary when the crown line is not parallel to pavement edge line.

B. Follow manufacturer guidelines for equipment calibration and maintenance.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by Lot.

2. Dispute resolution, Section 01 35 10.

3. Opening a profiled surface to traffic does not constitute acceptance.

4. Observation of CONTRACTOR's field quality control testing does not constitute acceptance. Such testing, however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. Profile Roughness:

1. Lot is 0.1 lane mile (528 feet long one lane wide). Add segments shorter than 250 feet to preceding lot. Treat partial segments longer than 250 feet as a lot.

2. Excluded from the lot are turn lanes, parking lanes, medians, Street Fixtures, crowns of intersecting streets, bridge decks, grades greater than eight (8) percent, and vertical curves less than 1,000 feet radius (including super-elevation transitions).

C. Profile Deviation: Verify "Must Grind" bumps and depressions are removed from the lot surface. Lot is area of total placement. No area is excluded.

1.6 DEFINITIONS

A. Must Grind: Areas of roadway pavement not meeting profile deviation tolerance.

B. Road Class: Attribute of a public or private thoroughfare based upon equivalent single axle loads (ESAL).

1. Class I: (ESAL < 10^4 per year). Includes maintenance mixes, bike paths, parking lots, residential driveways, light traffic residential streets, light traffic rural farm roads.

2. Class II: (ESAL between 10^4 and 10^6 per year). Includes heavy traffic residential streets, rural farm collector roads, non-industrial parking lots, urban low volume collector streets.

3. Class III: (ESAL > 10^6 per year). Includes high volume collectors, arterials, industrial parking lots (primary load from 3-axle or greater vehicles), climbing lanes, truck weigh stations.

C. Wheel Path: A continuous parallel line inside a travel lane 2.5 feet from the lane line or median line.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Profilograph:

1. Capable of producing results required by ASTM E950 and ASTM E1274.

2. Set profilograph readings with corresponding project survey stationing, or as a minimum, correlate equipment station 0+00 with a specific project station number. ENGINEER to select.

B. Milling and Grinding Machines:

1. Equipped to prevent air pollution.

2. Equipped with a system to control depth and slope of pavement cut.

C. Cleaning equipment able to pick up millings and waste water.

D. Equipment for applying emulsion and penetrating sealer, as required.

E. Equipment for patch repair for both bituminous and Portland cement concrete pavements.

3.2 PREPARATION

A. Traffic Control: Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.” Provide safe passage for pedestrians and vehicles. Do not proceed without certified flaggers if work requires.

B. Surface Repair: Method of payment to be determined by ENGINEER if preliminary profiling of existing pavement is required before placement of thin bonded overlay, micro-surfacing, slurry seal, chip seal, etc.

C. Clean the surface before any repair work or application of emulsion/sealer, ensuring that it is free of debris, dirt, and dust.

3.3 TOLERANCES

A. Profile Roughness and Profile Deviation: Verify bumps and depressions meet tolerance. Trace all wheel paths in direction of travel. Begin traces 50 feet before edge of new pavement or patch and end traces 50 feet after edge of new pavement or patch. Areas (including the 50 feet end trace areas) exceeding profile deviation tolerance are “Must Grind” areas.

Table 1 – Roughness and Deviation Tolerance

Speed mph	Road Class	Profile Roughness Index (PRI) Inches / Mile				Profile Deviation Inches/25 feet Maximum
		IRI		PI		
		Min	Max	Min	Max	
0 to 30	I II or III	– 129	– 177	– 46	– 66	0.4 0.4
31 to 45	I or II III	90 70	155 90	35 21	50 35	0.4 0.4
>45	All Classes	–	70	–	21	0.3

NOTES:

1) IRI (International Roughness Index), ASTM E 950. Use a 1/4 car.
2) PI (Profile Index), ASTM E 1274. Use a zero blanking band.
3) Profile deviation applies to bump and depression measurements.

3.4 REPAIR

A. General:

1. Do not begin repairs without ENGINEER's knowledge of such activity.
2. All repair expenses are at no additional cost to OWNER.
3. Complete repairs in a timely manner to minimize disruptions to traffic flow.

B. Bituminous Concrete Repair:

1. Smooth out profile irregularities by grinding. See Section 32 01 26 "Grinding Pavement."
2. Apply Section 32 12 03 "Asphalt Binders" cationic or anionic emulsion at 0.11 ± 0.01 gallons per square yard and a sand friction blotter over all grind areas.
3. If depressions cannot be corrected by grinding, do a cold mill and inlay repair per Section 32 01 16.71 "Cold Milling Bituminous Pavement" or do a remove and replace patch repair per Section 33 05 25 "Pavement Restoration." Raising depressions with a skin patch and feathered edges is NOT ACCEPTABLE. Patch profile must meet this section's smoothness requirements.

C. Portland Cement Concrete Repair:

1. Smooth out profile irregularities by grinding. See Section 32 01 26 "Grinding Pavement."
2. Apply penetrating sealer over all grind areas. See Section 07 19 00 "Water Repellent."
3. If depressions cannot be corrected by grinding, remove concrete and provide a concrete pavement patch per Section 32 01 19 "Patching Rigid Paving." Patch profile must meet this section's smoothness requirements.

3.5 POST-REPAIR INSPECTION

A. Upon completion of repairs, perform a post-repair inspection with the ENGINEER to ensure the smoothness profile meets the specified requirements and tolerances. Address any additional concerns or corrective measures as directed by the ENGINEER.

END OF SECTION

SECTION 32 01 34

WHITE TOP INLAY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Portland cement concrete inlays in existing bituminous pavements.

1.2 REFERENCES

A. ASTM Standards:

1. C1116 Fiber-Reinforced Concrete and Shotcrete.
2. C1399 Obtaining Average Residual Strength of Fiber-Reinforced Concrete.

1.3 SUBMITTALS

A. Section 32 13 13 “Concrete Paving.”

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Section 32 13 13 “Concrete Paving.”

1.6 DEFINITIONS

A. Inlay: A volume with sides and a bottom located within an existing roadway pavement surface.

B. Moderate Exposure Condition: Exposure in a climate where freezing is expected but where concrete will not be continually exposed to moisture or free water for long periods before freezing and will not be exposed to deicing agents or other aggressive chemicals.

C. Severe Exposure Condition: Exposure to deicing chemicals or other aggressive agents or where the concrete may become highly saturated by continued contact with moisture or free water before freezing.

1.7 FIELD CONDITIONS

A. Section 32 13 13 “Concrete Paving.”

1.8 NOTICE

A. Section 32 13 13 “Concrete Paving.”

PART 2 – PRODUCTS

2.1 CONCRETE

A. Concrete: Fiber reinforced, 4000 psi minimum, ASTM C1116.

B. Aggregate: Maximum size one-third of white top thickness.

C. Fiber: Synthetic, with a minimum strength of 80 psi, ASTM C1399.

1. 3 pounds per cubic yard.

2. 1.5 inches long.

D. Slump: Over four (4) inches requires ENGINEER's acceptance.

E. Air Content: Severe exposure unless specified otherwise.

Table 1 - Total Air Content, Percent

Nominal Maximum Aggregate Size, (in.)	Mild Exposure	Moderate Exposure	Severe Exposure
1	3.0	4.5	6.0
3/4	3.5	5.0	6.0
1/2	4.0	5.5	7.0
3/8	4.5	6.0	7.5

PART 3 - EXECUTION

3.1 PREPARATION

A. Mill bituminous surface to depth specified. Remove debris and loose particles. Pressure wash exposed surface. Allow surface to dry before proceeding.

B. Do not place concrete when the bituminous surface temperature is less than 35 deg F.

C. Cool hot bituminous pavement surfaces to 100 deg F or less. Allow surface to dry before proceeding.

D. Do not allow traffic on pavement once final cleaning is performed.

3.2 FORMWORK

A. Section 03 11 00 "Concrete Forming."

3.3 PLACEMENT

A. Section 03 30 10 "Concrete Placement" and as follows:

1. Do not move concrete horizontally with vibrator.

2. 1/8 inch in 10 feet tolerance.

3. Uniform and sharp corners. Do not use excess mortar to build up slab edges or round slab corners.

3.4 FINISH

A. For Speed Less Than 45 mph: 1/16 inch deep burlap drag, turf drag, or broom.

B. For Speed 45 mph and Greater: 1/8 inch deep groove 80 degrees to the crown line and randomly spaced between 3/8 and 1-1/2 inches.

3.5 CURE

A. Section 03 39 00 “Concrete Curing.”

B. Apply at two (2) times the manufacturer’s recommended rate Type II.

C. Class A or B (white pigmented) membrane forming compound. Apply total coverage in two (2) directions for total white coverage on all exposed surfaces after texturing.

D. Eliminate thermal shock by keeping ground and air temperature close to cure temperature.

3.6 JOINTS

A. General:

1. Construct joints at locations, depths and dimensions indicated or match alignment of joints in adjacent panels.

2. Minimum angle between any two intersecting joints is 90 degrees plus or minus 10 degrees.

3. Joints must intersect pavement free edges at a 90 degree angle and extend straight for a minimum of 1-foot from the free pavement edge.

B. Contraction Joints:

1. Single saw cut 1/8 inch wide, 1/3 slab depth.

2. Saw transverse joints first.

3. Saw only when concrete is hard enough to prevent raveling and finish sawing before conditions favor uncontrolled cracking.

4. The larger the dimension of any panel shall not exceed 125 percent of the smaller dimension. If drawings do not indicate joints spacing, provide the following.

Table 2

White Top Thickness, (in.)	Approximate Spacing, (ft.)
2	2-3
2.5	2.5-3.5
3	3-4
3.5	3.5-5.0
4	4-6

C. Isolation Joints: F1 sheet 1/2 inch thick, Section 32 13 73 “Concrete paving Joint Sealants.” Use this joint where pavement abuts building, manholes and other fixed objects.

D. Joint Sealing: Not required.

3.7 PROTECTION AND REAPIRS

A. General: All expenses are at no cost to OWNER.

B. Protection: Immediately after placement, protect concrete from graffiti or other types of mechanical injury.

C. Repair:

1. Remove and replace cracked panels.

2. Patch spall with Section 03 61 00 “Cementitious Grouting” shrinkage resistant grout.

3. Remove graffiti.

3.8 OPENING TO TRAFFIC

A. Not sooner than 3,000 psi.

END OF SECTION

SECTION 32 01 90

MAINTENANCE OF PLANTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Landscape maintenance and replacement.
2. Guarantees.
3. Irrigation system maintenance and repair.
4. Pest and disease control.
5. Pruning and trimming.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Not Applicable.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Seeded areas will be accepted at end of maintenance period when seeded areas are established and have been mowed at least three (3) times.

B. All other areas will be accepted not less than 60 days after planting and successful growth.

1.6 GRASS MAINTENANCE

A. General: Maintain surfaces until work is accepted, but in any event for a period of not less than 60 days after planting. Supply additional topsoil where necessary, including areas affected by erosion or settlement.

B. Watering: Water to ensure uniform seed germination and to keep surface of soil damp. Apply water slowly so soil will not puddle and crust.

C. Fertilizing: Fertilize during seeding and two (2) weeks after seeding and sodding. Apply 16-0-0 fertilizer (NPK ratio) in fall season following manufacturer’s recommendations.

D. Mowing:

1. Mow times are 7:00 to 10:00 a.m. or 5:00 to 8:00 p.m. Height three inches.

2. Clean cut with sharp blade. Do not cut more than 1/3 of blade at any one mowing. Remove clippings. After first mowing, water to moisten soil from three (3) inches to five (5) inches deep. Allow a minimum of five (5) days between mowings.

E. Grading: Roll when required to remove minor depressions or irregularities.

F. Weeding: When using herbicides, apply in accordance with manufacturer's recommendations. Remedy damage from improper use.

G. Protection and Repair: Protect planted areas with warning signs during maintenance period. Erect temporary fences, or barriers, to control pedestrians when necessary. Repair, reseed or resod areas showing rodent damage, erosion damage and other damage.

H. Pest and Disease Control: Monitor turf areas for signs of pests or diseases. Apply appropriate treatments in accordance with manufacturer's recommendations and best practices for landscape management.

1.7 TREES, PLANTS, AND GROUND COVER MAINTENANCE

A. General: Care for planted areas. Maintain, water, weed, repair, and protect until work is accepted, but in any event for a period of not less than 60 days after planting. Supply additional topsoil where necessary, including areas affected by erosion or settlement.

B. Watering: After planting, keep ground continuously moist until healthy growth is established. Thereafter, thoroughly water once a day until work is accepted. Prevent erosion.

C. Weeding: Uproot and remove weeds completely. Do not allow growth and germination of weed seeds. Fill holes caused by weeding with topsoil and rake smooth.

D. Protection: Protect planted areas against traffic by erecting barricades and warning signs. Replant damaged planted areas.

E. Maintain wrappings, guys, turnbuckles, and stakes. Adjust turnbuckles to keep wires tight. Repair or replace accessories when required.

F. Prune broken or dead branches. Replace sub-standard sized plants that required excessive pruning to American Nurseryman Standards.

1.8 IRRIGATION SYSTEM MAINTENANCE

A. Repair installed pressurized Irrigation Systems to operate properly.

B. Repair erosion or settlement around Street Fixtures and Irrigation System components.

C. Winterize system by October 15. Use compressed air at 100 psi only in pressurized systems. Do not put 100 psi air through drip circuits. Coordinate with ENGINEER.

D. Repair Irrigation System components broken by CONTRACTOR.

E. Pest and Disease Control: Monitor trees, plants, and ground cover for signs of pests or diseases. Apply appropriate treatments in accordance with manufacturer's recommendations and best practices for landscape management.

1.9 REPLACEMENTS

A. When any portion of surface becomes gullied or otherwise damaged and planting has failed to grow, repair and replant.

B. At conclusion of maintenance period, replant areas showing root growth failure, bare or thin spots, and eroded or settled areas with materials of like kind and size as specified for original planting.

C. Throughout the maintenance period, replace any unsatisfactory or dead plants within 10 days of written notice.

1.10 GUARANTEE

A. Guarantee begins after Irrigation System and plant installation inspections and acceptance have been completed and continues for one calendar year, or as specified elsewhere.

B. Replace plant materials found dead or not in healthy growing conditions with plant materials of same size and species with a new guarantee commencing on date of replacement.

C. At end of guarantee period if landscaped surfaces have settled causing poor drainage conditions, correct grade deficiencies. Make corrections after receiving approval of corrective methods and schedules.

D. Perform corrective work at no additional cost to OWNER.

1.11 INTEGRATED PEST MANAGEMENT (IPM)

A. Develop and implement an Integrated Pest Management (IPM) plan to prevent and manage pest problems in a way that minimizes the use of chemical pesticides and reduces the risk to human health and the environment.

B. Employ a combination of cultural, physical, biological, and chemical control methods to manage pests, prioritizing non-chemical methods whenever possible.

C. Monitor pest populations regularly to detect potential problems early and determine the most appropriate control strategies.

D. Use targeted, low-toxicity chemical pesticides only as a last resort and ensure that they are applied by a licensed applicator in accordance with all applicable regulations and label instructions.

E. Maintain records of all pest monitoring, prevention, and control activities, including the specific methods used and any chemical pesticides applied.

1.9 MULCHING AND EROSION CONTROL

A. Apply mulch to all planting beds, tree bases, and other specified areas to help conserve soil moisture, suppress weed growth, and moderate soil temperatures.

B. Use organic mulches such as shredded bark, wood chips, or compost, or inorganic mulches such as gravel or crushed stone, as specified in the project documents or approved by the ENGINEER.

C. Maintain mulch at a consistent depth throughout the maintenance period, typically 2-4 inches for organic mulches and 1-2 inches for inorganic mulches, taking care not to pile mulch against plant stems or trunks.

D. Inspect and repair erosion control measures, such as silt fences, straw wattles, or sediment basins, as necessary to ensure their proper function and prevent soil erosion and sedimentation.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION NOT USED

END OF SECTION

SECTION 32 01 91

TREE ROOT CUTTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cutting and removing tree roots.
2. Protecting surface improvements from future tree root growth.
3. Ensuring tree health and safety during and after root cutting procedures.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Upon ENGINEER’s request, submit a copy of arborist's ISA certificate and registration number on file with the State Division of Commercial Code.

B. Submit a Tree Root Cutting Plan that includes methods, equipment, and schedule of proposed work for ENGINEER’s review and approval.

1.4 QUALITY ASSURANCE

A. Provide an ISA certified arborist to observe tree root cutting.

B. Ensure compliance with all local, state, and federal regulations related to tree root cutting and disposal.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PROJECT CONDITIONS

A. Provide written watering instructions to neighbors in property abutting the tree root cuts to advise them of the tree's watering requirements.

B. Notify the ENGINEER of any potential conflicts with underground utilities, structures, or other obstructions prior to cutting tree roots.

PART 2 – PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 AVOIDING ROOT CUTS

A. When placing or replacing concrete sidewalk:

1. Adjust alignment to curve around, over or away from tree trunks. Do not proceed in this work until alignment has been reviewed by ENGINEER.

2. Adjust thickness and concrete contraction joints.

B. When replacing concrete curb and gutter:

1. Adjust thickness and concrete contraction score marks over tree roots.

2. Do not vary gutter invert from straight grade.

3. Use root barriers or other approved methods to prevent root intrusion into concrete or pavement surfaces.

3.2 CUTTING TREE ROOTS

A. Never cut buttress roots [i.e. roots at the broadened base of the tree trunk] without written authorization of arborist. Avoid injury to trunk.

B. Keep root cutting at least four (4) feet away from tree trunk. Limit cutting to one side of tree unless authorized otherwise in writing by arborist.

C. Cut roots clean and straight (no ragged or torn edges). Use an axe, saw, or appropriate equipment that properly cuts roots. Do not make partial root cuts.

D. Do not injure roots to remain.

E. Cut roots back to root laterals.

3.3 BACKFILLING

A. Backfill all cut and exposed roots the same day of root cutting, or cover with wood chips, mulch and water until backfilling is accomplished.

B. Place soil below root cut.

C. To prevent vertical root growth, place an impermeable membrane over root cuts. Bend membrane edges to plane below cut root. Place backfill materials adjacent to and above impermeable membrane.

3.4 PROTECTION

A. After cutting roots of tree:

1. Immediately water tree after backfilling.

2. Apply a minimum of 1 inch of water over the entire area under the tree canopy and well beyond over a period of four (4) hours.

3. Restrict water runoff.

4. Monitor tree health for signs of stress or decline for at least one year following root cutting. Notify ENGINEER of any concerns and coordinate with arborist to develop and implement remedial measures as necessary.

END OF SECTION

SECTION 32 01 93

PRUNING TREES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pruning branches of existing trees.

2. Ensuring tree health and safety during and after pruning procedures.

1.2 REFERENCES

A. ANSI Standards:

1. A300 Tree Care Operation - Tree, Shrub, and Other Woody Plants.

2. Z133.1 Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and Cutting Brush - Safety Requirements.

B. ISA Standards: Standards for Pruning.

C. UCFC Standards: Shade Tree Pruning Standards

1.3 SUBMITTALS

A. Tree protection plan that identifies trees to be pruned and reasons for pruning.

B. Upon ENGINEER's request, submit a copy of arborist's ISA certificate and registration number on file with the State Division of Commercial Code.

1.4 QUALITY ASSURANCE

A. Provide an ISA certified arborist to observe tree pruning.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 PRUNING PAINT

A. Formulated for horticultural application to cut or damaged plant tissue.

2.2 DISINFECTANT

A. Chlorine based.

PART 3 - EXECUTION

3.1 PREPARATION

A. Pruning work in any publicly owned right of way requires CONTRACTOR notifying adjacent property owner and giving them a brief description of why and how the work will be done. Notification needs to be given at least two (2) weeks before any work is done so property owner has a chance to respond if they choose to do so. The arborist selected to provide pruning service shall provide the notices. A written record of delivery dates of notices by address is required of the arborist.

B. Pruning trees on private property require tree owner approval. ENGINEER and CONTRACTOR shall jointly contact the owners for approval before performing any work.

3.2 TREE PRUNING

A. Adhere to safety requirements, ANSI A133.1.

B. Conform to ANSI A300 and the Utah Shade Tree Pruning Standards when pruning.

C. Conform to OSHA 1910.269 if there are power or communication lines within the area occupied by the tree's branches or adjacent to the tree.

D. Remove tree branches extending over the roadway to provide a clear height of:

1. 16 feet over the travel lane. The travel lane means the lane vehicles typically use for travel that is different than the parking lane which is adjacent to the curb normally used for parking.

2. 14 feet over the driveway approach.

3. 12 feet over finished grade.

4. 6 feet over street light.

5. 12 feet over signal light.

E. The contracted arborist may need to reduce the above referenced clearances based on tree size, species, or location.

F. Remove dead, diseased, damaged, broken, hanging, obstructing, crossing or weak branches.

G. Prune trees to make them shapely, symmetrical, and typical of the natural form of the species being pruned. Thin no more than 25 percent of the live canopy. Do not remove branches that would deform the appearance of the tree.

H. Cut deadwood back to existing callous growth. Do not remove callous growth.

I. Reduce length of limbs as ordered by ENGINEER.

J. Do not remove any live branch larger than six (6) inches in diameter unless authorized by ENGINEER.

K. Pre-cut branches to reduce weight of final cut. Select final cuts by location of branch bark ridge and branch collar.

L. No intermodal final cuts permitted unless authorized by ENGINEER.

M. The use of climbing spurs (gaffs) is prohibited.

N. Disinfect pruning equipment that comes in contact with diseased plant material. Remove disinfectant from equipment before proceeding with work.

O. Use the "Natural Target" or "Drop Crotch" pruning method when removing limbs.

P. Do not top, pollard, stub or dehorn any tree.

Q. Make all pruning cuts sufficiently close to the trunk or parent limbs without cutting into or removing the "branch collar" or the "branch bark ridge."

3.3 BRANCH DISPOSAL

A. Remove branches from site.

B. Remove all wood chips.

END OF SECTION

SECTION 32 05 10

BACKFILLING ROADWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roadway backfill materials.

2. Roadway backfilling requirements.

1.2 REFERENCES

A. APWA (Utah) Standards:

1. Plan 245 Subgrade stabilization.

B. ASTM Standards:

1. D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).

2. D1557 Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

3. D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. D4832 Preparation and Testing of Soil-Cement Slurry Test Cylinders.

1.3 SUBMITTALS

A. Submit maximum laboratory dry density and optimum laboratory moisture content for:

1. Subgrade material.

2. Each type of fill to be used.

B. Submit aggregate batch delivery tickets showing name of material source, serial number of ticket, date and truck number, name of Supplier, job name and location, volume or weight, and aggregate classification or Supplier's identification code.

1.4 QUALITY ASSURANCE

A. Do not change material sources, or aggregate without ENGINEER's knowledge.

B. Reject backfill material that does not comply with requirements specified in this section.

C. If requested, submit a quality control Inspection and testing report describing source and field quality control activities performed by CONTRACTOR and Suppliers.

D. Ensure all backfill materials have a Material Safety Data Sheet (MSDS) on file and comply with relevant environmental and safety regulations.

1.5 ACCEPTANCE

A. General: Native material may be wasted if there is no additional cost to substitute material acceptable to ENGINEER.

B. Material: For material acceptance refer to:

1. Common fill, Section 31 05 13.

2. Aggregate base courses, Section 32 11 23.

3. Cement treated fill, Section 31 05 15.

C. Lift Thickness: One test per Lot.

D. Compaction: One test per Lot. Verify density using nuclear tests, ASTM D2922. Compaction standard and Lot size as follows:

Table 1 – Compaction Standard and Lot Sizes

Material	Proctor	Lot Size
Subgrade	Standard	1000 square yards
Common Fill	Standard	PCC or AC Surface Course: 1,000 square yards per lift Driveway Approach: 400 square feet per lift Sidewalk: 400 linear feet per lift
Aggregate base course	Modified	PCC or AC Surface Course: 1,000 square yards per lift Driveway Approach: 400 square feet per lift Sidewalk: 400 linear feet per lift Curb, Gutter, and Waterways: 200 linear feet per lift
NOTES: 1) Standard proctor, ASTM D698. 2) Modified proctor, ASTM D1557.		

E. Flowable Fill Strength: Lot size is one day production with sub-lots of 250 cubic yards or part thereof. Verify strength using cylinders, ASTM D4832.

F. Grade, Cross Slope: Measured at random locations.

G. Compaction: One test per Lot for moisture-density relationship, in addition to the density test, as per ASTM D3017.

1.6 DEFINITIONS

A. Embankment: A raised earthen structure.

B. Pavement: A surface or covering, as of Portland cement concrete, bituminous concrete, brick, concrete paver, etc., specifically a paved street, sidewalk, curb, gutter, curb cut assembly, ramp, apron, Driveway, etc.

C. Subgrade: A surface of native earth or Rock leveled off as to receive backfill materials.

1.7 STORAGE

A. Safely stockpile backfill materials.

B. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.

1.8 SITE CONDITIONS

A. Do not place, spread, or roll any backfill material over material that is damaged by water. Remove and replace damaged material at no additional cost to OWNER.

B. Control traffic and erosion. Keep area free of trash and debris. Repair settled, eroded, and rutted areas.

C. Reshape and compact damaged structural roadway section to required density.

D. Soil Cement: Do not spread soil cement mixture when air temperature is less than 40 deg F in the shade.

E. Drainage: Immediately before suspension of construction operations for any reason, provide proper and necessary drainage of work area.

1.9 WARRANTY

A. Repair incidental settlement or settlement damage at no additional cost to OWNER.

PART 2 - PRODUCTS

2.1 BACKFILL MATERIALS

A. Common fill, Section 31 05 13: Granular material, CONTRACTOR’s choice.

B. Aggregate base course, Section 32 11 23: Untreated base course.

C. Cement treated fill, Section 31 05 15: Use a flowable fill so vibration is not required.

D. Recycled materials: When feasible and acceptable by the ENGINEER, use recycled materials as backfill, per Section 31 23 23 “Backfilling for Structures”.

2.2 WATER

A. Make arrangements for sources of water during construction and make arrangements for delivery of water to site.

B. Comply with local Laws and Regulations at no additional cost to OWNER when securing water from water utility company.

2.3 GEOTEXTILE

A. Stabilization separation fabric, Section 31 05 19 “Geotextiles”: Woven, high MARV.

2.4 EROSION CONTROL

A. Utilize erosion control measures such as silt fences, sediment basins, and vegetative cover, as required by the applicable permit, to prevent erosion and sedimentation during construction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.”

B. Verify:

1. Backfill material meets gradation requirements.

2. Areas to be backfilled are free of debris, snow, ice or water.

3. Bearing surfaces are not frozen.

C. If ground water is in the intended backfill zone, dewater.

3.2 PROTECTION

A. Protect existing trees, shrubs, lawns, structures, fences, roads, sidewalks, paving, curb and gutter and other features.

B. Protect above or below grade utilities. Contact utility companies to repair utility damage. Pay all cost of repairs.

C. Avoid displacement of and damage to existing installations while compacting or operating equipment. Do not fill adjacent to structures until excavation is checked by ENGINEER.

D. Do not use compaction equipment adjacent to walls or retaining walls that may cause wall to become over-stressed or moved from alignment.

E. Do not disturb or damage foundation perimeter drainage, foundation, damp-proofing, foundation waterproofing and protective cover, or utilities in trenches. Movement of construction machinery over work at any stage of construction is solely at CONTRACTOR’s risk.

F. Restore any damaged structure to its original strength and condition.

3.3 LAYOUT

A. Identify required line, levels, contours, and datum.

B. Stake and flag locations of underground utilities.

C. Upon discovery of unknown utility or concealed conditions, notify ENGINEER.

D. Maintain all benchmarks, control monuments and stakes, whether newly established by surveyor or previously existing. Protect from damage and dislocation.

E. If discrepancy is found between Contract Documents and site, ENGINEER shall make such minor adjustments in the Work as necessary to accomplish the intent of Contract Documents without increasing the Cost of the Work to CONTRACTOR or OWNER.

3.4 SUBGRADE

A. Protect Subgrade from desiccation, flooding, and freezing.

B. Before backfilling over Subgrade, get ENGINEER's review of Subgrade surface preparations.

C. If Subgrade is not readily compactable, get ENGINEER's permission to stabilize the Subgrade:

1. Excavation for Subgrade stabilization is incidental work. Section 31 23 16 "Excavation."

2. Place geotextile fabric per APWA Plan 245. Place acceptable fill in lifts over the geotextile, compact and wrap.

D. Ensure that the subgrade surface is uniformly graded, free of soft spots, and free of standing water before backfilling.

3.5 EMBANKMENTS

A. Place backfill material in lifts not exceeding equipment compaction capability.

B. Build shoulders to a grade higher than that of adjacent fills. Provide surface runoff at all times.

C. Commence compaction along edge of area to be compacted and gradually advance toward center.

D. Operate compaction equipment along lines parallel or concentric with the center-line of the embankment being constructed.

E. Do not damage subsurface structures or utilities.

3.6 BASE COURSES

A. Place backfill material in lifts not exceeding eight (8) inches before compaction.

B. Maintain moisture content in compaction operations.

C. Use a lightweight deflectometer (LWD) or falling weight deflectometer (FWD) to verify stiffness and uniformity of the base course, as per ASTM E2835 and ASTM D4694, respectively.

D. Avoid segregation when spreading backfill. Keep surfaces free from pockets of coarse and fine aggregate.

E. Rework fills that do not conform to compaction requirements until requirements are met.

F. Protect cement treated fill against freezing and traffic for seven (7) days.

3.7 MODIFIED BACKFILL LAYER METHOD

A. Section 33 05 20 “Backfilling Trenches.”

3.8 TOLERANCES

A. Compaction: Ninety-five (95) percent or greater relative to a standard or modified proctor density, Section 31 23 26 “Compaction.”

B. Lift Thickness (before compaction):

1. Eight (8) inches when using riding compaction equipment.

2. Six (6) inches when using handheld compaction equipment.

3. As proven in the modified backfill layer method, Section 33 05 20 “Backfilling Trenches.”

C. Cement Treated Fill: Compressive strength targets are 60 psi in 28 days. Maximum is 90 psi in 28 days.

3.9 FIELD QUALITY CONTROL

A. Record and provide compaction test results, including GPS coordinates of test locations, to the ENGINEER in a timely manner.

B. Test roadway backfilling until a compaction pattern acceptable to CONTRACTOR and ENGINEER is achieved. Continue random quality control compaction testing.

C. Proof Rolling Test:

1. Before placing fill material for roadbed backfills, proof roll subgrade using gross weight of 18,000 pounds/tandem axle, with a tire pressure at least 90 psi.

2. All proof roll passes will traverse the subgrade parallel to the roadbed centerline. All subsequent passes will be offset 1/2 the vehicle width until the entire subgrade is tested.

3. ENGINEER will analyze, determine, designate and measure the areas, if any, requiring additional compaction or reconstruction.

4. Once subgrade passes the proof rolling test, protect the surface from construction operations and traffic damage. Repair all cuts, ruts, and breaks. Keep surface in a satisfactory condition until geotextile fabric or base course has been placed.

3.10 CLEANING

A. Remove stockpiles from site when work is complete. Grade site to prevent free standing surface water.

B. Leave borrow areas clean and neat.

3.11 MAINTENANCE

A. Maintain backfilled areas until the project is complete, including addressing any erosion, settlement, or drainage issues that may arise.

END OF SECTION

SECTION 32 11 23

AGGREGATE BASE COURSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Treated and untreated base course production and placement.

1.2 REFERENCES

A. AASHTO Standards:

1. R9 Acceptance Sampling Plans for Highway Construction.

B. ASTM Standards:

1. C29 Unit Weight and Voids in Aggregate.
2. C131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
3. C117 Materials Finer Than 0.075mm (No. 200) Sieve in Mineral Aggregates by Washing.
4. C136 Sieve Analysis of Fine and Coarse Aggregates.
5. D75 Sampling Aggregates.
6. D448 Sizes of Aggregate for Road and Bridge Construction.
7. D1557 Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
8. D1883 CBR (California Bearing Ratio) of Laboratory-Compacted Soils.
9. D2216 Laboratory Determinations of Water (Moisture) Content of Soil and Rock.
10. D2419 Sand Equivalent Value of Soils and Fine Aggregate.
11. D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
12. D3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
13. D3665 Random Sampling of Construction Materials.
14. D3740 Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

15. D4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

16. D5821 Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.

1.3 SUBMITTALS

A. Mix Design: Provide the following. Allow ENGINEER 10 days to evaluate the submittal.

1. Date of mix design. If older than 365 days from date of submission, recertify mix design.

2. Name of supplier and aggregate source.

3. Target gradation for each sieve size.

4. Percent composition of reclaimed asphalt or concrete included in the mix.

5. Unit weight, CBR, relative density, and relative moisture content.

6. Aggregate physical properties (this section article 2.1). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than 455 days from date of submission.

B. At Delivery: Submit batch delivery ticket identifying serial number of ticket, date and truck number, job name, weight of aggregate, mix identification, and description.

1.4 QUALITY ASSURANCE

A. Do not change aggregate source until ENGINEER accepts new source and new mix design.

B. Use a laboratory that follows and complies with ASTM D3740 and Section 01 45 00 “Quality Control” requirements.

C. If requested, submit a quality control and testing report describing source and field quality assurance activities performed by CONTRACTOR and Suppliers.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by Lot.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring complying material as part of its installation, Section 01 29 00 “Payment Procedures.”

3. ENGINEER is not obligated to accept changes in gradation target after any material is delivered to site.

4. Observation of CONTRACTOR's field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements in Section 01 35 10 are met.

5. Dispute resolution, Section 01 35 10.

B. Gradation: Lot size is one (1) day production. Sub-lot size is 500 tons. Collect samples from grade before compaction. Conduct at least one (1) gradation analysis for each lot. Lot is acceptable if gradation test deviations are within pay factor 1.00 limits. At ENGINEER's discretion, a lot with a sub-lot deviation greater than pay factor 0.70 limits may stay in place at 50 percent pay.

Table 1- Gradation Pay Factors

Criteria	Pay Factor	Mean of Deviations of Acceptance Tests From the Target Grading Curve Expressed in Percentage Points				
		1 Sample	2 Samples	3 Samples	4 Samples	5 or More Samples
1/2" and Larger Sieves	1.00	0 – 15	0.0 – 12.1	0.0 – 10.8	0.0 – 10.0	0.0 – 9.5
	0.95	16 – 17	12.2 – 13.9	10.9 – 12.4	10.1 – 11.5	9.6 – 11.
	0.90	18 – 19	14.0 – 15.1	12.5 – 13.5	11.6 – 12.5	11.1 – 11.9
	0.80	20 – 21	15.2 – 17.2	13.6 – 15.3	12.6 – 14.2	12. – 13.5
	0.70	22 – 23	17.3 – 18.8	15.4 – 16.7	14.3 – 15.5	13.6 – 14.7
3/8" Sieve	1.00	0 – 15	0.0 – 11.5	0.0 – 9.8	0.0 – 8.8	0.0 – 8.0
	0.95	16 – 17	11.6 – 13.2	9.9 – 11.3	8.9 – 10.1	8.1 – 9.2
	0.90	18 – 19	13.3 – 14.4	11.4 – 12.3	10.2 – 11	9.3 – 10.0
	0.80	20 – 21	14.5 – 16.3	12.4 – 13.9	11.1 – 12.5	10.1 – 22.4
	0.70	22 – 23	16.4 – 17.9	14.0 – 15.2	12.6 – 13.6	11.5 – 12.4
No. 4 Sieve	1.00	0 – 14	0.0 – 10.5	0.0 – 8.8	0.0 – 7.8	0.0 – 7.0
	0.95	15 – 17	10.6 – 12.1	8.9 – 10.1	7.9 – 9.0	7.1 – 8.0
	0.90	18	12.2 – 13.1	10.2 – 11	9.1 – 9.8	8.1 – 8.7
	0.80	19 – 20	13.2 – 14.9	11.1 – 12.5	9.9 – 11.1	8.8 – 10.0
	0.70	21 – 22	15.0 – 16.3	12.6 – 13.6	11.2 – 12.1	10.1 – 10.8
No. 16 Sieve	1.00	0 – 11	0.0 – 8.2	0.0 – 6.9	0.0 – 6.2	0.0 – 5.6
	0.95	12 – 13	8.3 – 9.4	7.0 – 7.9	6.3 – 7.1	5.7 – 6.4
	0.90	14	9.5 – 10.3	8.0 – 8.6	7.2 – 7.8	6.5 – 7.0
	0.80	15 – 16	10.4 – 11.6	8.7 – 9.8	7.9 – 8.8	7.1 – 8.0
	0.70	17	11.7 – 12.7	9.9 - 10.7	8.9 – 9.6	8.1 – 8.7
No. 200 Sieve	1.00	0 – 4.5	0.0 – 3.4	0.0 – 2.9	0.0 – 2.5	0.0 – 2.3
	0.95	4.6 – 5.2	3.5 – 3.9	3.0 – 3.3	2.6 – 2.9	2.4 – 2.6
	0.90	5.3 – 5.6	4.0 – 4.3	3.4 – 3.6	3.0 – 3.1	2.7 – 2.9
	0.80	5.7 – 6.4	4.4 – 4.9	3.7 – 4.1	3.2 – 3.6	3.0 – 3.3
	0.70	6.5 – 7.0	4.9 – 5.3	4.2 – 4.5	3.7 – 3.9	3.5 – 3.6

NOTES:

1) ENGINEER has 36 hours after Lot placement to accept aggregate gradation. CONTRACTOR may place material over the crushed aggregate base material during the 36 hours interval at its own risk. Pay factors for the Lot will NOT be applicable if ENGINEER performs tests after the 36 hours interval.

C. Relative Density: Lot size 10,000 cubic yards. Conduct at least one laboratory determination to be used as a standard for field density and field moisture content determinations.

D. Field Density: Lot size is one (1) day placement. Number of density tests varies according to placement type, location and sub-lot size (Table 2). Conduct at least one (1) field density test in the lot. Select each test location randomly.

Table 2 - Placement Type, Location, Sub-lot Size

Type	Location	Sub-lot Size
I	Pavement (includes curb, gutter and water way when in conjunction with pavement placement).	1,000 square yards
II	Curb, gutter, waterway	200 linear feet
	Sidewalk	400 linear feet
	Driveway approach, curb cut assembly, waterway transition structure, flat work	400 square feet
III	Landscaping and other non-structural, non- load bearing areas	--

1.6 DEFINITIONS

A. Master Grading Band: A graphical area defined by gradation limits allowed for various sieve sizes ranging from the maximum sieve size to the No. 200 sieve.

B. Target Grading Curve: A smooth locus of points within the limits of the Master Grading Band.

C. Target Grading Band: Gradation limits defined by the allowable variance from the Target Grading Curve. It is possible that these limits may lie outside of the Master Grading Band.

D. Mean of Deviations: The sum of the absolute values of the variance between each screen target value and each measured value divided by the number of tests in the Lot.

E. RAP: Acronym for reclaimed asphalt pavement. See Section 32 12 16, “Asphalt Paving.”

F. Lot: (a) Quantity of aggregate delivered to a site when considering gradation, (b) area of aggregate placed at a site when considering density.

PART 2 - PRODUCTS

2.1 UNTREATED BASE COURSE

A. Material: Crushed rock, gravel, sand, or other high quality mineral particle, or combination that is free of organic matter, free of chemical or petroleum contamination, and meets the following physical properties.

Table 3 – Untreated Base Course Physical Properties

	ASTMs	Aggregate Class		
		A	B	C
Coarse aggregate				
Angularity (2 fractured faces), min., percent	D5821	50	–	–
Wear (toughness or hardness), max., percent	C131	50		
Fine aggregate				
Liquid Limit, max.	D4318	25		
Plastic Index, max.	D4318	0	0	6
Sand Equivalent, min., percent	D24 19	35		
Blended aggregate				
Dry Rodded Unit Weight, min., percent	C29	75		
CBR, min., percent	D1883	70	55	–

NOTES:

1) Faces: Retained on No. 4 sieve.
2) Wear: Retained on No. 12 sieve after 500 revolutions.
3) Liquid limit and plastic index: Passing No. 40 sieve.
4) Sand equivalent (clay content or cleanliness): Passing No. 4 sieve.
5) CBR: Use a surcharge of 10 pounds measured at 0.20 inch penetration at 95 percent relative to a modified proctor density. A reduction in aggregate class may be accepted providing any costs for difference in excavation, backfill, and alternate design for CBR does not increase Concrete Price.

B. Gradation: Analyzed according to ASTM C136 on a dry weight and percent passing basis. Target Grading Curve must lie within the selected aggregate grade in table 4. Field gradation shall not vary from target by more than the target tolerance.

Table 4 – Master Grading Bands

Sieve	Aggregate Grade			Target Tolerance
	Grade 1-1/2	Grade 1	Grade 3/4	

1-1/2"	100	–	–	(Pay factor 1.00 in Table 1)
1 "	–	100	–	
3/4 "	70 – 85	–	100	
1/2 "	–	79 – 91	–	
3/8 "	55 – 75	–	78 – 92	
No. 4	40 – 65	49 – 61	55 – 67	
No. 16	25 – 40	27 – 35	28 – 38	
No. 200	7 – 11	7 – 11	7 – 11	

NOTES:

1. It is assumed fine and course aggregate have same bulk specific gravity.
2. Target tolerance for 3/4 sieve in Grade 3/4, and 1” sieve in Grade 1 is not applicable.
3. Percentage of fines passing No. 200 sieve determined by washing, ASTM C117.

C. Changing Source: A new material properties report is required.

2.2 TREATED BASE COURSE

A. Treatment includes addition of lime, cement slurry, asphalt emulsion, RAP, crushed concrete, or any combination, or other material acceptable to ENGINEER.

B. Base course containing RAP:

1. Meet requirements of this section article 2.1 and the following:

a. Sand equivalent and fractured face measured after asphalt residue is burned off.

b. Plasticity and wear requirements apply to virgin aggregate portion only.

c. Allowable asphalt content is controlled by allowable CBR.

2. Remove debris from crushed RAP aggregate by screening.

3. Mechanically blend virgin and RAP aggregates. Do not use windrows for blending.

C. Base course containing crushed concrete.

1. Meet requirements of this section article 2.1 and the following:

a. Cement with its chemical components is allowed.

b. Wear test and fractured face test not required.

2.3 SOURCE QUALITY CONTROL

A. Reject crushed aggregate base products that do not meet requirements of this Section.

B. Sampling Protocol: Random location selection, ASTM D3665. Sample collection, ASTM D75.

C. Testing Protocol: Gradation, ASTM C136. Maximum density, ASTM D1557. Optimum moisture content, ASTM D2216.

PART 3 - EXECUTION

3.1 PREPARATION

A. Subgrade Preparation:

1. Prior to placing the aggregate base course, ensure the subgrade is compacted, free of standing water, and meets the required grade and cross-section.

2. Remove soft or unsuitable material and replace it with an approved material.

3. Compact the subgrade to at least 95% of the maximum dry density according to ASTM D1557.

B. Proof Rolling:

1. Perform proof rolling on the prepared subgrade with a pneumatic-tired roller, vibratory roller, or other approved equipment to detect any soft spots, yielding areas, or other deficiencies.

2. Repair any deficiencies detected during proof rolling before proceeding with the placement of the aggregate base course.

C. See other related Sections:

1. Trenches, Section 33 05 20 “Backfilling Trenches.”

2. Structures, Section 31 23 23 “Backfilling for Structures.”

3. Landscaping, Section 32 91 19 “Landscape Grading.”

4. Pavements, Section 32 05 10 “Backfilling Roadways.”

3.2 PLACEMENT

A. General:

1. Place uniform lifts not exceeding eight (8) inches before compaction.

2. Maintain optimum moisture content plus or minus two (2) percent.

3. Use appropriate compaction equipment.

4. Avoid segregation of material during placement.

5. Do not place additional material on any unaccepted layer or on any frozen surface.

B. Provide aggregate suitable for the following locations.

Table 5 - Placement Type, Location, Aggregate Class

Type	Location	Aggregate Class		
		A	B	C
I	Pavement (includes curb, gutter and waterway when in conjunction with pavement placement)	**X**		
II	Concrete flat work (includes driveway approach, curb cut assembly, curb, gutter, sidewalk, waterway, etc.	**X**	**X**	
III	Landscape (includes non-structural, non-load bearing areas.	**X**	**X**	**X**

NOTES:

1) **X** indicates where placement is allowed.

C. Compaction:

1. Type I and Type II Placement: 95 percent of the maximum dry density according to ASTM D1557.

2. Type III Placement: Suitable to overlying surface, or installation, or use. Verify compactive effort with ENGINEER.

3. Ensure the moisture content of the material is within the optimum moisture content range during compaction.

4. If the material is too wet, allow it to air-dry or use other approved drying methods before proceeding with compaction.

D. Finish: Uniform with surface deviation no more than 3/8 of an inch from line and grade in 10 feet in any direction.

1. After compaction, shape the surface of the aggregate base course to meet the required grade and cross-section.

2. Maintain the aggregate base course during and after compaction to prevent ruts, humps, or other surface irregularities.

3.3 TESTING AND ACCEPTANCE

A. Field Density and Moisture Content:

1. Conduct in-place density tests in accordance with ASTM D2922 and moisture content tests in accordance with ASTM D3017.

2. Perform tests at a minimum frequency of one test per 2,000 square feet (185 square meters) or as specified by the ENGINEER.

B. Surface Tolerance:

3. Check the surface tolerance of the completed aggregate base course using a 10-foot (3-meter) straightedge or other approved methods.

4. The surface tolerance shall not exceed 1/2 inch (12 mm) in 10 feet (3 meters).

C. Correction of Deficiencies:

5. Correct any deficiencies identified during testing and acceptance in accordance with the project requirements and applicable standards.

6. Re-test the corrected areas to ensure compliance with the project requirements.

3.2 FIELD QUALITY CONTROL

A. Sampling Protocol: Random location selection, ASTM D3665. Sample collection, ASTM D75.

B. Testing Protocol: Gradation, ASTM C136. Field density, ASTM D2922. Moisture content, ASTM D3017.

3.3 REPAIR OR REMOVAL

A. If product is correctable and at no additional cost to OWNER, provide laboratory data showing design CBR has not been reduced and material in-place has been compacted to 97 percent minimum.

B. Remove any product that cannot be corrected and install acceptable product at no additional cost to OWNER.

3.4 PROTECTION AND CLEANUP

A. Protect the completed aggregate base course from damage due to construction traffic or other activities.

B. Repair any damage to the aggregate base course before placing subsequent materials, such as asphalt or concrete pavements.

C. Remove any debris or excess material resulting from the placement and compaction of the aggregate base course from the site.

END OF SECTION

SECTION 32 11 24

PULVERIZED PAVEMENT BASE COURSE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Full depth reclamation by pulverizing and mixing an existing bituminous pavement and road base in-place to produce a bituminous-aggregate base course mix.

1.2 REFERENCES

A. ASTM Standards:

1. C136 Sieve Analysis of Fine and Coarse Aggregates.
2. C150 Portland Cement.
3. C595 Blended Hydraulic Cement.
4. D558 Moisture-Density Relations of Soil-Cement Mixtures.
5. D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. D4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
7. D5102 Unconfined Compressive Strength of Compacted Soil-Lime Mixtures.

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26 “Traffic Control.”

B. List of equipment to be used.

C. Mix design showing percentage and quantity of stabilizer needed.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Gradation: Random measure.

B. Depth: Random measure each 1,000 square yards.

C. Density: Nuclear gage or proof roll.

D. Quantity of stabilizer added matches submittal data.

PART 2 - PRODUCTS

2.1 TACK COAT CURING COMPOUND

A. Cationic or anionic emulsified asphalt, Section 32 12 03 “Asphalt Binders.”

2.2 STABILIZER

A. Cement:

1. Type I or II, ASTM C150, or

2. Type IP or IS, ASTM C595.

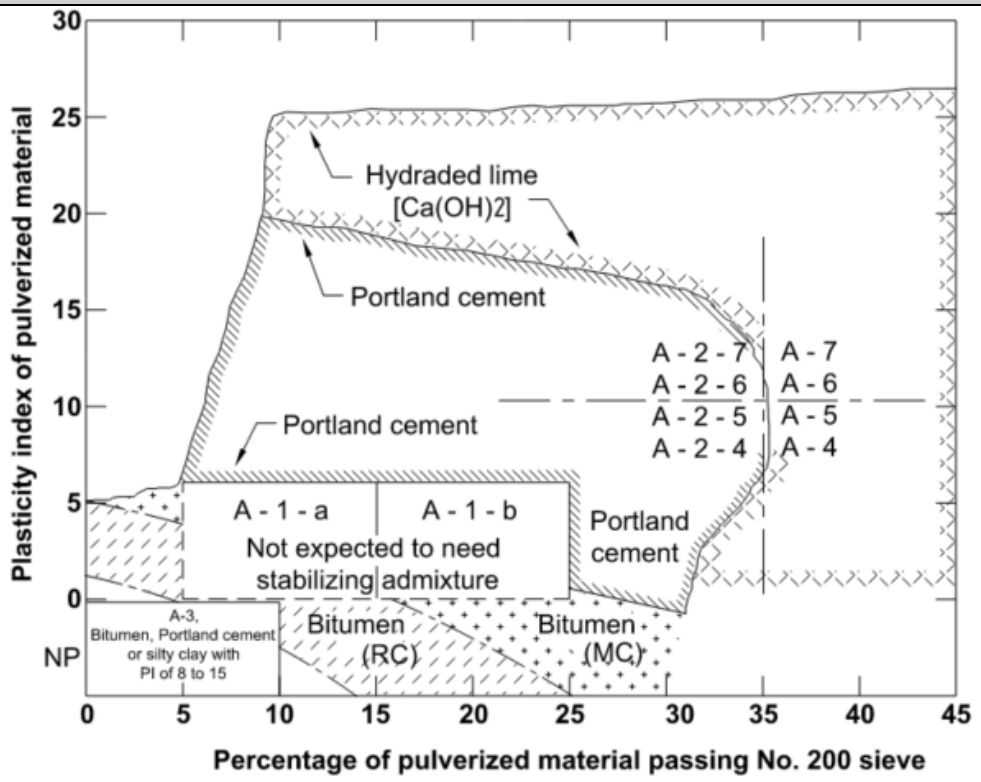
B. Aggregate: Gravel, untreated base course, crushed Portland cement concrete.

C. Chemical Stabilizer: Use type allowed by ENGINEER.

2.3 MIX DESIGN

A. Stabilizer Selection: If required, use the following table as a guide. The amount and type should be determined by laboratory tests.

Table 1 – Stabilizer Selection Guide



Characteristics of Reclaimed Aggregate Before Addition of Stabilizer	Stabilizer
Bituminous Binder content is greater than 15 percent.	Aggregate

Material passing No. 4 sieve is more than 45 percent.	Aggregate or Cement
Material passing No. 4 sieve has a plasticity index more than 10, (ASTM D4318)	Cement or Chemical
NOTES: 1) Unless indicated elsewhere, cement stabilization per ASTM D5102 is to be in the range of 300 to 800 psi at seven (7) days.	

B. Gradation, ASTM C136.

Table 2 – Percent Passing	
Sieve	**By Weight**
3”	100
1”	85 to 95
No. 4	45 maximum

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Pulverizing Machine: Capable of cutting to the required depth, pulverizing, and sizing the material.

3.2 PREPARATION

A. Identify location of all buried utilities.

B. Notify neighborhood of day and time of operation.

C. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.”

D. Install Invert Covers, Section 01 71 13.

E. Lower Street Fixtures.

F. Determine need for stabilizer.

3.3 CONSTRUCTION

A. Pulverize full depth of bituminous pavement and untreated base course.

B. Control dust, Section 01 57 23 “Pollution Controls.”

C. Do not remove pulverized material from site. To meet specified grade, remove material below the pulverized product.

D. If stabilizer is required, add stabilizer and pulverize a second time.

E. Shape, grade, roll, compact.

F. Cure stabilized material with water or asphalt tack coat.

3.4 FIELD QUALITY CONTROL

A. Compaction:

1. Reclaimed Aggregate: Ninety-five (95) percent or greater relative to a modified proctor density, Section 31 23 26 “Compaction.” Use the following procedures:

a. Optimum water content and maximum density, ASTM D558.

b. Nuclear gage shallow depth, ASTM D2922.

2. Stabilized Reclaimed Aggregate: Proof Roll (after cement set).

3.5 REPAIR

A. Repair surface irregularities.

B. Seal cracks in cured stabilized material.

3.6 OPENING TO TRAFFIC

A. Completed portions of pulverized pavement can be opened to low-speed traffic and to construction equipment, provided the curing material or moist curing operations are not impaired and provided the pulverized material is sufficiently stable to withstand marring or permanent deformation.

B. After the pulverized material has received a curing compound or a subsequent overlay surface, or is sufficiently stable to withstand marring or permanent deformation it may be opened to all traffic.

END OF SECTION

SECTION 32 12 03

ASPHALT BINDERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. An asphalt-based cement that is produced from petroleum residue either with or without the addition of non-particulate, non-fibrous organic modifiers.

2. Requirements for accepting non-complying Asphalt Binders.

1.2 REFERENCES

A. ASTM Standards:

1. D113 Ductility of Bituminous Materials.

2. D977 Emulsified Asphalt.

3. D2026 Cutback Asphalt (Slow-Curing Type).

4. D2027 Cutback Asphalt (Medium-Curing Type).

5. D2028 Cutback Asphalt (Rapid-Curing Type).

6. D2397 Cationic Emulsified Asphalt.

7. D3381 Viscosity-Graded Asphalt Cement for Use in Pavement Construction.

8. D4552 Classifying Hot-Mix Recycling Agents.

9. D5710 Trinidad Lake Modified Asphalt.

10. D6373 Performance Graded Asphalt Binder.

1.3 SUBMITTALS

A. Submit bill of lading for each shipment of Asphalt Binder from vendor. Identify the following:

1. Source of product (manufacturer).

2. Type and grade of asphalt, and

3. Type and amount of additives in the product.

1.4 QUALITY ASSURANCE

A. Reject Asphalt Binders that are not uniform in appearance and consistency or foams at hot mixing temperature.

B. Do not use storage containers contaminated with other types or grades of petroleum products.

C. Do not use petroleum product that does not comply with contract requirements.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by Lot. One (1) Lot is one (1) day production.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring material as part of its installation. Section 01 29 00 “Payment Procedures.”

3. Dispute resolution, Section 01 35 10.

B. Performance Graded Asphalt Binder (PGAB): Sub-lot size is 20,000 gallons. Collect sub-lot Samples randomly from oil storage unit.

1. Meet limits published in Section 209 of UDOT’s “Manual of Instruction, Part 8 Materials”. Pay reductions are as follows:

a. If none of the critical properties are outside rejection limit a composite pay adjustment of 25 percent or less is allowed.

b. If one or more of the critical properties falls outside the rejection limit or if a composite pay adjustment is more than 25 percent, Asphalt Binder will be rejected.

C. Asphalt Cement (AC) Binder: Sub-lot size is 20,000 gallons. Collect sub-lot Samples randomly from oil storage unit.

1. Ductility: Meet this section’s requirements, or

2. Viscosity or Penetration: Meet graphics published in Section 955 of UDOT’s “Manual of Instructions, Part 8 Materials”:

a. Lot may be accepted using the published graphics. If pay adjustment exceeds 30 percent, reject Asphalt Binder, or

b. If allowed to remain after placement, pay adjustment will be 50 percent.

D. Cut-back Binder: Meet this section’s requirements for ductility.

E. Trinidad Lake Modified Asphalt: Supplier’s certificate for ASTM compliance.

F. Emulsified Asphalt: Supplier’s certificate for ASTM compliance.

G. Recycle Asphalt: Identity of source (asphalt cement or tar products).

H. Crack Patch: Meet material requirements in Section 32 01 17 “Sealing Cracks in Bituminous Paving.”

1.6 ENVIRONMENTAL REQUIREMENTS

A. Ensure storage and handling of Asphalt Binders are conducted in compliance with all local, state, and federal environmental regulations.

B. Materials shall be contained in a manner to prevent spills or leakage into the surrounding environment.

1.7 PRODUCT STORAGE

A. Store materials in designated areas away from incompatible substances.

B. Implement effective preventive measures against contamination or adulteration of the Asphalt Binders.

PART 2 - PRODUCTS

2.1 PERFORMANCE GRADE ASPHALT BINDER (PGAB)

A. Petroleum asphalt that complies with ASTM D6373. Blending binder with polymers, crumb rubber, or natural bitumens is CONTRACTOR’s choice.

2.2 ASPHALT CEMENT (AC)

A. Petroleum asphalt that complies with Table 2 of ASTM D3381 except as follows:

1. Replace ductility, ASTM D113, at 77 deg F (25 deg. C) with ductility at 39.2 deg F (4 deg. C). Use the following values:

   a. AC-5: greater than 25.

   b. AC-10: greater than 15.

   c. AC-20: greater than 5.

2. Delete the loss on heating requirement on residue from "Thin-Film Oven Test".

B. AC-5 Latex Additive: Anionic emulsion of butadiene-styrene low- temperature copolymer consisting of two (2) percent by weight (solids basis), stabilized with fatty-acid soap for storage stability.

2.3 TRINIDAD LAKE MODIFIED ASPHALT (TLA)

A. Petroleum asphalt that complies with ASTM D5710 (a blend of natural bitumens).

2.4 SLOW CURE CUT-BACK ASPHALT (SC)

A. Petroleum asphalt that complies with ASTM D2026 (fluxed with a light oil) except if penetration of residue is more than 200 and its ductility at 77 deg. F (25 deg. C) is less than 100 cm., the material will be acceptable if the ductility at 59 deg F (15 deg. C) is greater than 100.

2.5 MEDIUM CURE CUT-BACK ASPHALT (MC)

A. Petroleum asphalt that complies with ASTM D2027 (fluxed or blended with a kerosene type solvent, non-foaming when heated to application temperature) except if penetration of residue is more than 200 and its ductility at 77 deg F (25 deg. C) is less than 100 cm., the material will be acceptable if the ductility at 59 deg F (15 deg. C) is greater than 100.

2.6 RAPID CURE CUT-BACK ASPHALT (RC)

A. Petroleum that complies with ASTM D2028 asphalt (fluxed or blended with a naphtha solvent, non-foaming when heated to application temperature).

2.7 EMULSIFIED ASPHALT

A. Petroleum asphalt uniformly emulsified with water, homogeneous throughout, and when stored, shows no separation within 30 days after delivery. Frozen emulsions not accepted:

1. Anionic, ASTM D977 (breaks by evaporation).

2. Cationic, ASTM D2397 (breaks chemically).

2.8 RECYCLE ASPHALT (RA)

A. Petroleum asphalt that complies with ASTM D4552 (homogeneous, free- flowing at pumping temperature made from maltene fractions of asphalt cement for surface revitalization or from tar products to make Pavements resistant to fuel spillage:

1. RA-1, RA-5, RA-25 or RA-75 for recycling RAP aggregate when less than 30 percent virgin aggregate is added.

2. RA-250 or RA-500 when more than 30 percent virgin aggregate is added to RAP.

2.9 WARM-MIX ASPHALT (WMA)

A. Performance grade Asphalt Binder or asphalt cement binder blended with a wax, foam, chemical, or organic additive.

2.10 AGGREGATES FOR ASPHALT

A. All aggregates used in the production of asphalt should comply with the requirements of ASTM D692 (for coarse aggregate) and ASTM D1073 (for fine aggregate).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prime coat, Section 32 12 13.19.

B. Tack coat, Section 32 12 13.13.

C. Hot-Mix Asphalt, Section 32 12 16.

D. Slurry seal coating, Section 32 01 13.61.

E. Sealing Cracks in Bituminous Paving, Section 32 01 17.

3.2 PERFORMANCE TESTING

A. Post-installation, conduct performance tests including skid resistance, moisture susceptibility, and deformation resistance tests in accordance with local governing authority regulations.

END OF SECTION

SECTION 32 12 05

BITUMINOUS CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Composition of a bituminous concrete mix.

1.2 REFERENCES

A. AASHTO Standards:

1. M323 Superpave Volumetric Mix Design, Single User Digital Publication.
2. R30 Mixture Conditioning of Hot-Mix Asphalt (HMA).
3. T324 Hamburg Wheel-Track Testing of Compacted Hot-Mix Asphalt (HMA).

B. AI Standards:

1. MS-2 Asphalt Mix Design Methods.

C. ASTM Standards:

1. C29 Unit Weight and Voids in Aggregate.
2. C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
3. C117 Materials Finer Than 0.075mm (No. 200) Sieve in Mineral Aggregates by Washing.
4. C131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
5. C136 Standard Method for Sieve Analysis of Fine and Coarse Aggregate.
6. C142 Clay Lumps and Friable Particles in Aggregates.
7. D75 Sampling Aggregates.
8. D140 Sampling Bituminous Materials.
9. D242 Mineral Filler for Bituminous Paving Mixtures.
10. D979 Sampling Bituminous Paving Mixtures.
11. D995 Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
12. D2041 Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures.

13. D2419 Sand Equivalent Value of Soils and Fine Aggregate.
14. D3203 Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures.
15. D3515 Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
16. D3665 Random Sampling of Construction Materials.
17. D3666 Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials.
18. D4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
19. D4552 Classifying Hot-Mix Recycling Agents.
20. D4791 Flat or Elongated Particles in Coarse Aggregate.
21. D4867 Effect of Moisture on Asphalt Concrete Paving Mixtures.
22. D5444 Mechanical Size Analysis of Extracted Aggregate.
23. D5821 Determining the Percentage of Fractured Particles in Coarse Aggregate.
24. D6307 Determining Asphalt Content of Hot-Mix Asphalt by Ignition Method.
25. D6373 Performance Graded Asphalt Binder.
26. D6927 Marshall Stability and Flow of Bituminous Mixtures.

1.3 SUBMITTALS

A. General:

1. Pre-approved Mix Design: Submit name and address of Supplier.
2. Allow ENGINEER 10 days to evaluate mixing equipment and mix design submittals.
3. Once a mix design is accepted, a new mix design submittal is required if the following occurs:
    a. Asphalt Binder grade is changed.
    b. Aggregate source is changed. When this occurs, submit a physical properties report on the proposed aggregates.
4. Quality Assurance:
    a. Independent Laboratory: Submit names, certification levels, and years of experience of testing agency’s field technicians that are assigned to the Work. Verify laboratory complies with ASTM D3666. and follows Section 01 45 00 requirements.

b. Mix Production Equipment: Submit verification by an individual acceptable to ENGINEER, that plant equipment complies with requirements of ASTM D995.

c. Testing Report: If requested by ENGINEER, submit a report of source and field quality control testing performed by CONTRACTOR and Suppliers.

B. Mix Design: Submit the following.

1. Date of mix design. If the date exceeds the following times, the mix design is invalid and must be redesigned.

a. One (1) year for non-commercial plants.

b. Two (2) years for commercial plants if there is no change in the aggregate source. A new mix design will be required if aggregate source is changed.

2. Binder source, type, and grade. Disclose if RAP or ROSP is used in the mix.

3. Optimum compaction temperature at the project site.

4. Theoretical maximum specific gravity.

5. Compaction density at design target air voids.

6. Target Grading Curve for aggregate.

7. Binder target percentage, dust to binder ratio, and the following as applicable.

a. For Superpave mix design provide 1) voids in the mineral aggregate (VMA), and 2) voids filled with Bituminous Binder also known as VFA, and 3) Hamburg Wheel Tracker results.

b. For Marshall mix design provide 1) tensile strength ratio (moisture sensitivity), 2) voids in the mineral aggregate (VMA), 3) stability, 4) flow and 5) voids in the bituminous mix, and 6) voids filled with Bituminous Binder also known as VFA.

c. Percentages of 1) mineral filler, 2) anti-strip, 3) reclaimed bituminous pavement (RAP or ROSP), 4) recycle agent in the mix, and 5) virgin aggregate.

d. Aggregate physical properties (this section article 2.2). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than two (2) calendar years from the date of submission.

1.4 QUALITY ASSURANCE

A. Do not change aggregate source or binder source until ENGINEER accepts new sources and mix design.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by Lot. One (1) Lot is one (1) days' production.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring material as part of its installation, Section 01 29 00 “Payment Procedures.”

3. If test results are not within this section’s limits, options include correction of production procedures or production of an alternate mix design acceptable to ENGINEER.

4. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements in Section 01 35 10 are met.

5. Dispute resolution, Section 01 35 10.

B. Mix Sampling and Testing:

1. Sub-lot size is 500 tons or part thereof.

2. Sampling Protocol: ASTM D3665 and ASTM D979. Collect at least one (1) random Sample per sub-lot from behind paver and before compaction. Any sample collected because of non-uniform appearance shall not be used in determining a pay factor for the Lot.

3. Testing Protocol: Field samples will be compacted in the laboratory and tested for:

a. Air voids, ASTM D3203.

b. Voids in the mineral aggregate, AI MS 2.

4. Binder content, ASTM D6307.

5. Aggregate gradation, ASTM D5444.

C. Pay Reduction: Lot is acceptable if binder content and aggregate gradation test deviations are within pay factor 1.00 limits in Table 1 or Table 2 as applicable. At ENGINEER’s discretion a Lot with a sub-lot test deviation greater than pay factor 0.85 limits may stay in place at 50 percent pay.

Table 1 – Pay Factors – Superpave Mix Design					
Criteria	**Pay Factor**	**Range of Mean of Deviations of Tests Results in Percentage Points from Binder and Gradation Targets**			
		500 Tons	**1,000 Tons**	**1,500 Tons**	**[3] 2,000 Tons**
Binder Content	1.00 0.975 0.95 0.90 0.85	0.0 – 0.7 0.71 – 0.8 0.81 – 0.9 0.9 – 1.0 1.01 – 1.1	0.0 – 0.54 0.55 – 0.61 0.62 – 0.68 0.69 – 0.75 0.76 – 0.82	0.0 – 0.46 0.47 – 0.52 0.53 – 0.58 0.59 – 0.64 0.65 – 0.69	0.0 – 0.41 0.42 – 0.46 0.47 – 0.52 0.53 – 0.56 0.57 – 0.61
1/2" and larger Sieve	1.00 0.975 0.95 0.90 0.85	0.0 – 10.0 11.0 – 12.0 13.0 – 13.9 14.0 – 14.9 15.0 – 16.0	0.0 – 7.3 7.4 – 8.3 8.4 – 9.3 9.4 – 10.3 10.4 – 11.3	0.0 – 6.3 6.4 – 7.1 7.2 – 7.9 8.0 – 8.7 8.8 – 9.5	0.0 – 5.6 5.7 – 6.3 6.4 – 7.0 7.1 – 7.7 7.8 – 8.4
3/8" Sieve	1.00 0.975 0.95 0.90 0.85	0.0 – 9.9 10.0 – 10.9 11.0 – 11.9 12.0 – 13.9 14.0 – 15.0	0.0 – 6.9 7.0 – 7.8 7.9 – 8.7 8.8 – 9.6 9.7 – 10.5	0.0 – 5.9 6.0 – 6.6 6.7 – 7.3 7.4 – 8.0 8.1 – 8.9	0.0 – 5.3 5.4 – 5.9 6.0 – 6.6 6.7 – 7.2 7.3 – 7.9
No. 4 Sieve	1.00 0.975 0.95 0.90 0.85	0.0 – 9.9 10.0 – 10.9 11.0 – 11.9 12.0 – 12.9 13.0 – 14.0	0.0 – 6.7 6.8 – 7.6 7.7 – 8.5 8.6 – 9.4 9.5 – 10.2	0.0 – 5.7 5.8 – 6.3 6.4 – 6.9 7.0 – 7.5 7.6 – 8.0	0.0 – 5.2 5.3 – 5.8 5.9 – 6.4 6.5 – 7.0 7.1 – 7.6
No. 8 Sieve	1.00 0.975 0.95 0.90 0.85	0.0 – 7.9 8.0 – 8.9 9.0 – 9.9 10.0 – 10.9 11.0 – 12.0	0.0 – 5.6 5.7 – 6.3 6.4 – 7.0 7.1 – 7.7 7.8 – 8.5	0.0 – 4.8 4.9 – 5.4 5.5 – 6.0 6.1 – 6.6 6.7 – 7.2	0.0 – 4.3 4.4 – 4.8 4.9 – 5.3 5.4 – 5.8 5.9 – 6.4

No. 200 Sieve	1.00 0.975 0.95 0.90 0.85	0.0 – 3.0 3.1 – 3.5 3.6 – 4.0 4.1 – 4.5 4.6 – 5.0	0.0-2.4 2.5 – 2.7 2.8 – 3.0 3.1 – 3.3 3.4 – 3.6	0.0 – 2.0 2.1 – 2.2 2.3 – 2.4 2.5 – 2.7 2.8 – 3.0	0.0 – 1.8 1.9 – 2.0 2.1 – 2.2 2.3 – 2.4 2.5 – 2.6

NOTES

1. Test binder content using a burn-off oven, ASTM D6307.
2. Determine aggregate gradation by extraction, ASTM D5444.

Table 2 – Pay Factors - Marshall Mix Design

Criteria	Pay Factor	Range of Mean of Deviations of Tests Results from the Binder and Gradation Targets in Percentage Points				
		500 Tons	1,000 Tons	1,500 Tons	2,000 Tons	[3] 2,500 Tons
Binder Content	1.00 0.975 0.95 0.90 0.85	0.00–0.70 0.71–0.80 0.81–0.90 0.91–1.00 1.01–1.10	0.00–0.54 0.55–0.61 0.62–0.68 0.69–0.75 0.76–0.82	0.00–0.46 0.47–0.52 0.53–0.58 0.59–0.64 0.65–0.69	0.00–0.41 0.42–0.46 0.47–0.52 0.53–0.56 0.57–0.61	0.00–0.38 0.39–0.43 0.44–0.47 0.48–0.52 0.53–0.56
1/2" and larger Sieve	1.00 0.975 0.95 0.90 0.85	0.0–10.9 11.0–12.9 13.0–13.9 14.0–14.9 15.0–16.0	0.0–7.3 7.4–8.3 8.4–9.3 9.4– 10.3 10.4–11.3	0.0–6.5 6.4–7.1 7.2–7.9 8.0–8.7 8.8–9.5	0.0–5.6 5.7–6.3 6.4–7.0 7.1–7.7 7.8–8.4	0.0–5.2 5.3–5.8 5.9–6.4 6.5–7.1 7.2–7.7
3/8"Sieve	1.00 0.975 0.95 0.90 0.85	0.0–9.9 10.0–10.9 11.0–11.9 12.0–13.9 14.0–15.0	0.0–6.9 7.0–7.8 7.9–8.7 8.8–9.6 9.7–10.5	0.0–5.9 6.0–6.6 6.7–7.3 7.4–8.0 8.1–8.9	0.0–5.3 5.4–6.9 6.0–6.6 6.7–7.2 7.3–7.9	0.0–4.9 5.0–5.5 5.6–6.1 6.2–6.6 6.7–7.2

No. 4Sieve	1.00 0.975 0.95 0.90 0.85	0.0–9.9 10.0–11.0 11.1–11.9 12.0–12.9 13.0-14.0	0.0–6.7 6.8–7.6 7.7–8.5 8.6–9.4 9.5–10.2	0.0–5.7 5.8–6.3 6.4–6.9 7.0–7.5 7.6–8.0	0.0–5.2 5.3–5.8 5.9–6.4 6.5–7.0 7.1–7.6	0.0–4.8 4.9–5.4 5.5–5.9 6.0–6.5 6.6–7.0
No. 8Sieve	1.00 0.975 0.95 0.90 0.85	0.0–7.9 8.0–8.9 9.0–9.9 10.0–10.9 11.0–12.0	0.0–5.6 5.7–6.3 6.4–7.0 7.1–7.7 7.8–8.5	0.0–4.8 4.9–5.4 5.5–6.0 6.1–6.6 6.7–7.2	0.0–4.3 4.4–4.8 4.9–5.3 5.4–5.8 5.9–6.4	0.0–4.0 4.1–4.5 4.6–4.9 5.0–5.4 5.5–5.8
No. 16Sieve	1.00 0.975 0.95 0.90 0.85	0.0–7.9 8.0–8.9 9.0–9.9 10.0–10.9 11.0–12.0	0.0–5.2 5.3–5.8 5.9–6.4 6.5–7.0 7.1–7.6	0.0–4.6 4.7–5.1 5.2–5.6 5.7–6.1 6.2–6.6	0.0–4.2 4.3–4.6 4.7–5.1 5.2–5.5 5.6–5.9	0.0–3.9 4.0–4.3 4.4–4.7 4.8–5.1 5.2–5.4
No. 50Sieve	1.00 0.975 0.95 0.90 0.85	0.0–6.9 7.0–7.9 8.0–8.9 9.0–9.9 10.0–11.0	0.0–4.3 4.4–4.8 4.9–5.3 5.4–5.8 5.9–6.4	0.0–3.8 3.9–4.1 4.2–4.5 4.6–4.9 5.0–5.5	0.0–3.4 3.5–3.8 3.9–4.1 4.2–4.4 4.5–4.9	0.0–3.2 3.3–3.5 3.6–3.8 3.9–4.1 4.2–4.5
No. 200Sieve	1.00 0.975 0.95 0.90 0.85	0.0–3.0 3.1–3.5 3.6–4.0 4.1–4.5 4.6–5.0	0.0–2.4 2.5–2.7 2.8–3.0 3.1–3.3 3.4–3.6	0.0–2.0 2.1–2.2 2.3–2.4 2.5–2.7 2.8–3.0	0.0–1.8 1.9–2.0 2.1–2.2 2.3–2.4 2.5–2.6	0.0–1.7 1.8–1.9 2.0–2.1 2.2–2.3 2.4–2.5
NOTES: 1) Test binder content using a burn-off oven, ASTM D6307. 2) Determine aggregate gradation by extraction, ASTM D5444.						

D. Installation: See Section 32 12 16 acceptance requirements.

1.6 DEFINITIONS

A. Mix Designator: An alphanumeric code that identifies binder grade, aggregate grade, and compaction level for a bituminous concrete mix. For example.

1. *PG70-28, SP-1, 75Nd***:** PG70-28 is a Performance Graded Asphalt Binder. SP-1 is the aggregate grade. 75Nd is the compaction level at Superpave mix design.

2. *OS/PG, SP-3/4, 75Nd*: OS/PG is a Blended Binder. SP-3/4 is the aggregate grade. 75ND is the compaction level at Superpave mix design.

3. *PG64-22, DM-1/2, 50 blow*: PG64-22 is a Performance Graded Asphalt Binder. DM-1/2 is the aggregate grade. 50 blow is the compaction level at Marshall mix design.

4. *OS/PG, DM-3/4, 50 blow*: OS/PG is a Blended Binder. DM-3/4 is the aggregate grade. 50 blow is the compaction level at Marshall mix design.

B. Bituminous Binder: A cement composed of any of several viscous or solid mixtures of hydrocarbons and their nitrogen and sulfur derivatives.

1. Asphalt Binder: A refined or manufactured bituminous cement known as performance graded asphalt binder (PG or PGAB) whether virgin or contained in RAP.

2. Bitumen Binder: A natural bituminous cement contained in an Oil Sand (OS) or contained in a ROSP.

3. Blended Binder: A Mixture of Asphalt Binder and Bitumen Binder.

C. Mean of Deviations: Defined in Section 32 11 23 “Aggregate Base Courses.”

D. Nominal Maximum Size: One sieve size larger than first sieve size retaining more than 10 percent of the Sample. One hundred percent of the aggregate might be able to pass through the nominal maximum size sieve but not more than 10 percent will be retained on that sieve. The maximum size sieve will be one (1) sieve size larger than the nominal maximum size.

E. Oil Sand (OS): Naturally occurring sediments or sedimentary rock containing gravel, sand, clay, water and bituminous cement.

F. RAP: Acronym for reclaimed asphalt pavement. A granular product recovered from a bituminous pavement containing aggregate and an Asphalt Binder.

G. ROSP: Acronym for reclaimed Oil Sand pavement. A granular product recovered from a bituminous pavement containing aggregate and a Bitumen Binder.

PART 2 - PRODUCTS

2.1 BINDER

A. Performance Graded Asphalt Binder (PGAB): See ASTM D6373.

1. Blending with polymers is allowed.

2. Do not use acid blends without documentation supporting need.

3. Adjust binder grade according to AASHTO M323 to account for any binder stiffness caused by adding RAP or ROSP to the mix.

B. Bitumen Binder: Oil Sand (OS) source is CONTRACTOR’s choice.

C. Blended Binder: CONTRACTOR's choice. A blended ratio of Asphalt Binder to Bitumen Binder in the range of about 1:4 to about 4:1 may require patent licensure (Reference: US RE39, 289 E). CONTRACTOR to verify.

2.2 AGGREGATE

A. Crushed stone, crushed gravel, slag, sand, or combination.

B. Use Table 3 to determine suitability of aggregate source.

Table 3 – Aggregate Physical Properties

		Standard	Road Class	
			I & II	III
Coarse Aggregate				
Angularity, percent, minimum	One Fractured face	D5821	90	95
	Two Fractured faces		90	90
Wear (hardness or toughness), percent, maximum		C131	35	35
Flats or elongates (3:1 length to width), percent, maximum		D4791	--	20
Fine Aggregate				
Angularity (uncompacted void content), percent, minimum		T304	40	45
Sand equivalent, percent, minimum		D2419	45	60
Plastic limit, maximum		D4318	0	0
Blended Physical Properties				
Dry-rodded Unit Weight, lb/ft^3, minimum		C29	75	75
Weight Loss (Soundness), percent, maximum		C88	16	16
Friable particles, percent, maximum		C142	2	2

NOTES:

1) Road Class is defined in Section 32 01 31.
2) Course aggregate does not pass No. 4 sieve. Fine aggregate does pass.
3) Angularity is determined by weight.
4) Wear of aggregate may have higher values if aggregate source is known to have higher values.
5) Sand equivalent is waived for RAP or ROSP aggregate but applies to the remainder of the aggregate blend.
6) Plastic limit, passing No. 40 sieve. Aggregate is non-plastic even when filler material is added to the aggregate.
7) Weight loss, using sodium sulfate.
8) Friable particles are clay lumps, shale, wood, mica, coal passing the No. 4 sieve, and other deleterious materials.

2.3 ADDITIVES

A. Mineral Filler: ASTM D242.

B. Recycle Agent: ASTM D4552.

C. Anti-strip Agent: Heat stable cement slurry, lime slurry, or chemical liquid.

D. RAP or ROSP: Free of detrimental quantities of deleterious materials.

1. Allowed up to 15 percent by weight of RAP or binder, whichever is lesser, with no change in specified binder grade.

2. Allowed from 15 to 30 percent by weight of RAP or binder, whichever is lesser, if the binder grade is adjusted according to AASHTO M323 to meet the specified binder grade.

3. Determine RAP binder content by chemical extraction.

2.4 MIX DESIGN

A. Preparation:

1. Get the Mix Designator and the Road Class from the OWNER, ENGINEER, or bid documents.

2. Use paragraph 1.4C to determine submittal requirements.

B. Aggregate Gradation – Superpave Mix Design: See Table 4. The Target Gradation Curve for the specified aggregate grade must lie within the Master Grading Band limits. The target grading band limits for the Target Grading Curve are the appropriate grading limits for pay factor 1.00 in Table 1. The target grading band limits are allowed to extend outside of the Master Grading Band limits.

C. Aggregate Gradation – Marshall Mix Design: See Table 5. The Target Gradation Curve for the specified aggregate grade must lie within the Master Grading Band limits. The target grading band limits for the Target Grading Curve are the appropriate grading limits for pay factor in Table 2. The target grading band limits are allowed to extend outside of the Master Grading Band limits.

Table 4 - Master Grading Band Limits - Marshal Mix Design

Sieve	Aggregate Grades					
	DM-1	DM-3/4	DM-/2	OM-1/2	FM-1	FM-1/2
1 inch	100					
3/4 inch		100			100	
1/2 inch	75 - 91		100	100	90 - 100	100
3/8 inch		75 - 91		93 - 100	60 - 100	90 - 100
No. 4	47 - 61	46 - 62	60 - 80	36 - 44	15 - 40	30 - 50
No. 8				14 - 21	4 - 12	5 - 15
No. 16	23 - 33	22 - 34	28 - 42			
No. 50	12 - 22	11 - 23	11 - 23			
No. 200	3 - 7	3 - 7	3 - 7	2 - 4	2 -5	2 - 5

NOTES:

1) Gradation is expressed in percent passing by weight, ASTM C136. Percentage of fines passing No. 200 sieve determined by washing, ASTM C117.
2) Friction Mixture, ASTM D3515.
3) The alpha portion of the grade designator (DM, OM, FM) represents dense mix, open mix and friction mix. The numerical portion (1, 3/4, 1/2) represents the ***maximum*** sieve size.

D. Design Parameters: Determined by AI MS-2.

Table 5 - Mix Design Parameters

		SuperPave			Marshall	
Compaction Level	(b)	50Nd	75Nd	100Nd	50 blow	75 blow
Stability, lbs, minimum	(c)	--			1200	1800
Flow, in 0.01 inch units	(c)	--			10 - 18	
Design Air Void Target, percent (d)		3.5			3.5	
		ASTM D3203			ASTM D6927	
		Nominal Grading			Maximum Grading	
		1	12.0		1	13.0
		3/4	13.0		3/4	14.0

Voids in Mineral Aggregate (VMA) relative to maximum or nominal sieve size grading and calculated using Gsb(dry), percent, minimm	1/2	14.0	1/2	15.0
	3/8	15.0	3/8	16.0
RAP or ROSP specific gravity for calculations	Gsb (dry) by chemical extraction			
Dust to Binder Ratio, maximum	1.4		1.6	
Tensile Strength Ratio (moisture sensitivity), minimum(e)	-		0.80	
Rutting (Hamburg rut test)(f)	AASHTO T324			
Road Class I	--		--	--
Road Class II	15 mm/10,000 passes		--	--
Road Class III	10 mm/20,000 passes		--	--

NOTES

1) Road Class is defined in Section 32 01 31.
2) 100Nd mix is for very high traffic applications only as defined by ENGINEER. 100Nd mix is intended for lower lift applications or surface applications with proactive seal coat program.
3) Design Density Target: See ASTM D2041. Percent of maximum theoretical specific gravity.
4) Stability, Flow, Voids: See ASTM D6927.
5) Tensile Strength Ratio (moisture sensitivity): See ASTM D4867. Use freeze thaw conditioning. Compact test specimen to seven (7) percent plus or minus one (1) percent air voids.
6) With testing performed at temperatures representing the specified binder grade in the Hamburg rut test, the average rut depth of two (2) mix design test Samples is less than the amount shown for the respective Road Classes.

2.5 SOURCE QUALITY CONTROL

A. Collect Samples randomly, ASTM D3665. Do not change sampling points:

1. Sampling aggregate, ASTM D75. Collect samples before the drum mixer.
2. Sampling binder, ASTM D140.
3. Sampling bituminous paving mixture, ASTM D979.

B. Validate binder grade received from Supplier, Section 32 12 03 “Asphalt Binders.”

C. Test mix every production day for the following:

1. Combined aggregate gradation in the mix, ASTM D5444.

2. Binder content in the mix, ASTM D6307.

3. Temperature of mix placed in the transport vehicle at the production plant.

a. Asphalt Binder mixes.

1) Hot Mix: 325 deg F maximum.

2) Warm Mix: 325 deg F maximum.

b. Bitumen Binder mixes or Blended Binder mixes.

1) Hot Mix: NOT ALLOWED.

2) Warm Mix: 230 degrees maximum.

D. Warm Mix Testing: When rutting or moisture susceptibility tests are required on plant produced warm mix, condition the warm mix material before testing for two (2) hours at 275 plus or minus five (5) deg F per AASHTO R30 (short term aging). The material may be cooled to room temperature before conditioning.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Mixing Plant: ASTM D995. Provide.

1. Positive means to determine the moisture content of aggregate.

2. Positive means to sample all material components.

3. Sensors to measure the temperature of the mix at discharge.

4. Ability to maintain discharge temperature of mix.

5. Capability of maintaining plus or minus five (5) percent tolerance on component percentages in final mix.

6. Oil Sand Introduction System: Do not burn off the light oils in Bitumen Binder (oil sand).

B. Pavement placement, Section 32 12 16.

C. Pavement restoration, Section 33 05 25.

END OF SECTION

SECTION 32 12 08

RUBBERIZED ASPHALT CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mixing aggregate, rubber, and Asphalt Binder to make a rubberized bituminous concrete mix.

1.2 REFERENCES

A. ASTM Standards:

1. D5 Penetration of Bituminous Materials.
2. D36 Softening of Bitumen (Ring-and-Ball Apparatus).
3. D75 Sampling Aggregates.
4. D92 Flash and Fire Points by Cleveland Open Cup Tester.
5. D140 Sampling Bituminous Materials.
6. D242 Mineral Filler for Bituminous Paving Mixtures.
7. D979 Sampling Bituminous Paving Mixtures.
8. D995 Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
9. D2196 Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield type) Viscometer.
10. D3203 Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures.
11. D3665 Random Sampling of Construction Materials
12. D3666 Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials.
13. D4867 Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures.
14. D5329 Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements.
15. D5444 Mechanical Size Analysis of Extracted Aggregate.

16. D6114 Asphalt Rubber Binder.

17. D6307 Determining Asphalt Content of Hot-Mix Asphalt by Ignition Method.

18. D6373 Performance Graded Asphalt Binder.

19. D6927 Marshall Stability and Flow of Bituminous Mixtures.

1.3 SUBMITTALS

A. Quality Assurance:

1. Independent Laboratory: Submit names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM standards.

2. Mixing Equipment: Submit certification of plant equipment.

B. Asphalt Rubber Binder Compliance:

1. Submit the values obtained from the source quality control tests, along with the following information: percent, grade and source of the asphalt rubber binder used; and percent, gradation and source(s) of rubber used.

2. Provide a certificate from the asphalt rubber binder Supplier assuring that the rubber is derived from automotive, truck or other vehicle tire material.

C. Mix Design: Provide the following. Allow ENGINEER 10 days to evaluate the submittal.

1. Industry standard used for mix design (i.e. Marshall or Superpave). If the industry standard will be modified or a different mix design procedure will be used, get ENGINEER's approval.

2. Date of mix design. If older than 365 days from date of submission, recertify mix design.

3. Target Grading Curve for aggregate.

4. Dust to binder ratio, tensile strength ratio (moisture sensitivity), and percentage of Asphalt Binder in the mix.

5. Percentages of mineral filler, anti-strip, and tire rubber in the mix.

6. Aggregate physical properties (this section article 2.3): The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than 455 days from the date of submission.

D. Testing Report: If requested by ENGINEER, submit a report describing source and field quality control testing performed by CONTRACTOR and Suppliers.

1.4 QUALITY ASSURANCE

A. Use a laboratory that follows and complies with ASTM D3666 and follows Section 01 45 00 “Quality Control” requirements.

B. Do not change aggregate source or rubberized Asphalt Binder source until ENGINEER accepts a new source and a new mix design.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by Lot. One (1) Lot is one (1) day’s production.

2. If non-complying material has been installed and no price for the material is specified, apply price adjustment against cost of work requiring complying material as part of its installation, Section 01 29 00 “Payment Procedures.”

3. If test results are not within acceptable limits, options include correction of production procedures or production of an alternate mix design acceptable to ENGINEER.

4. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements in Section 01 35 10 are met.

5. Dispute resolution, Section 01 35 10.

B. Rubberized Asphalt Concrete Mix:

1. Sub-lot size is 500 tons or part thereof.

2. Sampling Protocol: ASTM D3665 and ASTM D979. Collect at least one random Sample per sub-lot form the following locations.

a. Behind paver before compaction, or

b. Where sub-lot exhibits non-uniform appearance.

3. Testing Protocol: Field samples will be compacted in the laboratory and tested for:

a. Air voids, ASTM D3203 or ASTM D6927.

b. Dust to binder ratio.

c. Asphalt content, ASTM D6307 and aggregate gradation, ASTM D5444.

1) Pay Reduction: Defective binder content or aggregate gradation defects may be accepted at reduced pay as indicated in Section 32 12 05 “Bituminous Concrete” (Superpave design or Marshall design) as applicable.

2) Installation: Acceptance requirements are stipulated in Section 32 12 16.

1.6 DEFINTIONS

A. Mix Designator: An alphanumeric code that identifies components of a rubberized asphalt concrete mix. For example:

1. *PG64-22, SP-1, 75Nd, TR*: PG64-22 is a Performance Graded Asphalt Binder. SP-1 is the aggregate grade. 75Nd is the compaction level at Superpave mix design. TR means the mix has a Tire Rubber modifier.

2. *PG64-22 DM-1/2, 50 blow. TR*: PG64-22 is a Performance Graded Asphalt Binder. DM-1/2 is the aggregate grade. 50 blow is the compaction level at Marshall mix design. TR means the mix has a Tire Rubber modifier.

PART 2 - PRODUCTS

2.1 ASPHALT BINDER

A. Performance Graded Asphalt Binder (PGAB), ASTM D6373: Able to produce properties indicated in ASTM D6114 when interacted with ground recycled tire rubber.

2.2 GROUND RECYCLED TIRE RUBBER

A. Contains less than 0.75 percent moisture, is free flowing, contains no more than 0.01 percent ferrous metal particles by weight, and has not more than 0.5 percent fabric in hot-mix applications. The use of rubber from multiple sources is acceptable provided that the overall blend of rubber meets gradation requirements.

B. Gradation: Percent passing No. 8 mesh is 100 percent.

C. Additives: Calcium carbonate or talc, up to four (4) percent by weight to prevent particles from sticking together.

2.3 AGGREGATE

A. Crushed stone, crushed gravel, slag, sand or combination with physical properties indicated for bituminous concrete mix (Marshall mix design or Superpave mix design). See Section 32 12 05 “Bituminous Concrete.”

2.4 ADDITIVES

A. Mineral Filler: ASTM D242.

B. Anti-strip Agent: Heat stable cement slurry or lime slurry.

C. Reclaimed Asphalt Pavement (RAP): NOT ALLOWED.

2.5 MIX DESIGN

A. Asphalt Rubber Binder: Type I, Type II, or Type III per ASTM D6114 with the following components.

Table 1 – Components of Asphalt Rubber Binder				
Property	**Standard**	**Binder Designation**		
		Type I	**Type II**	**Type III**
Climate		Hot	Moderate	Cold
Base Asphalt Binder	D6373	PG70-22	PG64-22	PG58-28
Rubber added to base Asphalt Binder, percent, min.	--	15	15	15

B. Additives: Cement or lime slurry for tensile strength in the mix, CONTRACTOR's choice.

C. Aggregate Structure and Mix Properties: Refer to Section 32 12 05 "Bituminous Concrete" for Superpave or Marshall aggregate structure and properties.

2.6 SOURCE QUALITY CONTROL

A. Collect Samples randomly, ASTM D3665. Do not change sampling points.

1. Sampling aggregates, ASTM D75. Collect sample before the drum mixer or after going through the drier.

2. Sampling asphalt rubber binder, ASTM D140.

3. Sampling bituminous pavement mixture, ASTM D979.

B. Do one (1) test of asphalt rubber binder every 20,000 gallons for the following properties.

1. Apparent viscosity, ASTM D2196 method A.

2. Penetration, ASTM D5.

3. Softening point, ASTM D36.

4. Resilience, ASTM D5329.

5. Flash point, ASTM D92.

6. Penetration retention, ASTM D75.

C. Test mix every production day for the following:

1. Combined aggregate gradation in the mix, ASTM D5444.

2. Asphalt Binder content in the mix, ASTM D6307.

3. Tensile strength of the mix, ASTM D4867.

4. Temperature of mix placed in the transport vehicle.

D. Equipment: Certify at least every two (2) years through the services of a design professional licensed in the State of Utah, that plant equipment complies with requirements of ASTM D995.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Mixing Plant: ASTM D995. Provide.

1. Positive means to determine the moisture content of aggregate.
2. Positive means to sample all material components.
3. Sensors to measure the temperature of the mix at discharge.
4. Ability to maintain discharge temperature of mix.
5. Capability of maintaining component percentages of final mix within acceptable industry standards.

3.2 INSTALLATION

A. Pavement placement, Section 32 12 16.

B. Pavement restoration, Section 33 05 25.

END OF SECTION

SECTION 32 12 13.13

TACK COAT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Application of asphaltic material to existing bituminous concrete or Portland cement concrete surfaces before placing a bituminous concrete pavement.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Certificate showing asphaltic material complies with Section 32 12 03 “Asphalt Binders”:

1. Identify water/asphalt dilution ratio.

2. Identify tack coat application rate.

B. Identify asphalt material recommended by fabric manufacturer.

1.4 QUALITY ASSURANCE

A. Ensure the application of Tack Coat is carried out by personnel skilled in this practice.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 WEATHER

A. Apply tack coat only when air and roadbed temperatures in the shade are greater than 40 deg F Temperature restrictions may be waived only with ENGINEER’s concurrence.

B. Do not apply tack coat during rain, fog, dust, or other unsuitable weather. Do not apply coat to wet surfaces.

1.7 NOTICE

A. Send written notice to residents or business owners 24 hours before applying coat.

PART 2 - PRODUCTS

2.1 ASPHALT MATERIAL

A. Select from the following:

1. Emulsified Asphalt: Grade MS-1, SS-1 or SS-1h, Section 32 12 03 “Asphalt Binders.”

2. Cationic Emulsified Asphalt: Grade CSS-1 or CSS-1h, Section 32 12 03 “Asphalt Binders.”

3. Rapid Cure Cutback Asphalt: Grade RC-70, Section 32 12 03 “Asphalt Binders.”

2.2 ADDITIVES

A. If necessary, include anti-stripping agents in the tack coat formulation. This will help to improve adhesion between the asphalt layers.

PART 3 – EXECUTION

3.1 PREPARATION

A. Select and advise ENGINEER of the type of tack material to be used.

B. Clean surface to be treated free of dust and other foreign material. If flushed, allow surface to dry. If leaves from trees, blow clean.

C. Provide safe pedestrian access across tack coat.

D. Prevent pedestrians, vehicles, pets, etc., access to tack surfaces.

3.2 APPLICATION

A. General:

1. Triple coverage by spray bar required. Stop application if any nozzle is not working properly.

2. Apply tack only to area covered with bituminous concrete in the same day.

B. Application Rate: Typically as follows:

1. Emulsions, 0.05 to 0.15 gallons per square yard.

2. Cutback, CONTRACTOR’s choice.

C. Tack for Fabric Application: Comply with manufacturer’s recommendation. If none, then as follows:

1. Dry pavement surface, 0.20 to 0.30 gallons per square yard. Within street intersections, on steep grades and in zones where vehicle speed changes are commonplace reduce application rate to no less than 0.20 gallons per square yard.

2. Heavy duty fabrics, 0.30 to 0.40 gallons per square yard.

3.3 PROTECTION

A. Protect all surfaces exposed to public view from being spattered or marred. Remove any spattering, over-coating, or marring.

B. Do not discharge bituminous material into borrow pits or gutters.

3.4 OPENING TO TRAFFIC AND MAINTENANCE

A. Do not permit traffic to travel over the tacked surface until bituminous tack coat has cured or is not picked up by traffic.

B. If detours cannot be provided, restrict operations to a width suitable at least for one-way traffic over the remaining portion of the road.

C. If one-way traffic is provided, control traffic appropriately.

3.5 TESTING

A. Conduct field tests to verify the viscosity, temperature, and rate of application of the tack coat.

B. The application rate of the tack coat should achieve complete coverage of the surface.

C. After application and prior to overlaying, inspect the tack coat for uniformity, adhesion, and absence of pooling or excessive thickness.

END OF SECTION

SECTION 32 12 13.19

PRIME COAT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Application of liquid asphalt to aggregate base before placing bituminous concrete or Portland cement concrete pavement.

2. Placing sand on areas that are over-primed.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Certificate showing asphaltic material complies with Section 32 12 03 “Asphalt Binders.”

B. Submit an environmental impact statement detailing the potential impacts and mitigation measures for the prime coat application process.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 WEATHER

A. Apply prime coat only when air and roadbed temperatures in the shade are greater than 40 deg F Temperature restrictions may be waived only with ENGINEER’s knowledge.

B. Do not apply prime coat in wind speeds exceeding 15 mph to prevent overspray or drift.

C. Do not apply prime coat during rain, fog, dust, or other unsuitable weather.

PART 2 - PRODUCTS

2.1 ASPHALT MATERIAL

A. Select from the following:

1. Slow Cure Cutback Asphalt: Grade SC-70, or SC-250, Section 32 12 03 “Asphalt Binders.”

2. Medium Cure Cutback Asphalt: Grade MC-30, MC-70, or MC-250, Section 32 12 03 “Asphalt Binders.”

3. Rapid Cure Cutback Asphalt: Grade RC-1, RC-2, or RC-250, Section 32 12 03 “Asphalt Binders.”

2.2 SAND

A. Clean natural aggregate passing the No. 4 sieve and retained on the No. 200 Sieve.

B. Sand must be sourced sustainably and comply with local, state, and federal regulations for use in construction projects.

PART 3 – EXECUTION

3.1 PREPARATION

A. If aggregate base course to be primed contains an appreciable amount of loose material or is excessively dusty; moisten, blade, roll, and recompact to make the surface dense.

B. Do not start priming until all free surface moisture has disappeared.

C. Notify residents and business owners 24 hours before applying prime coat.

D. Provide pedestrian access across prime coat if required.

E. Install barriers or signs around the work area to protect the public and prevent unauthorized access.

3.2 APPLICATION

A. If pavement surface is to be applied over loosely bonded surface, apply prime coat at 0.10 to 0.50 gallons per square yard to penetrate and seal. Do not flood surface.

B. Cure and dry as long as necessary to attain penetration and evaporation of volatile.

C. Blot over-primed surface with a light, uniform layer of sand.

D. Prime under-primed areas with additional asphalt.

3.3 PROTECTION

A. Protect all structures, including curb, gutter, sidewalks, guardrails and guide posts from being spattered or marred. Remove any spattering, over-coating, or marring at no additional cost to OWNER.

B. Do not discharge bituminous material into borrow pits or gutters.

C. Prevent tracking of prime coat onto adjacent surfaces.

3.4 OPENING TO TRAFFIC AND MAINTENANCE

A. Do not permit traffic to travel over freshly primed surface until prime coat has cured. If detours cannot be provided, restrict operations to a width suitable at least for one-way traffic over the remaining portion of the road. If one-way traffic is provided, control traffic by flagging or pilot car operation.

B. After prime coat application, leave work area undisturbed. If prime coat is tacky or tends to pick up under traffic after four (4) hours, blot excess prime coat with blotter sand. Prime coats can be opened to traffic after blotting.

C. Clean and maintain primed surfaces until surface pavement course is placed. Maintenance includes spreading any necessary additional blotter material, replacing all portions of prime coat that have been destroyed, and patching any break in primed surfaces.

D. Do not open primed surfaces to traffic until the ENGINEER has inspected and approved the work.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Comply with provisions indicated on Civil Drawings and with the additional provisions specified in this Section.

B. Related Requirements:

1. Section 01 60 01 "Buy America Requirements" for special product requirements.
2. Section 02 41 14 "Pavement Removal" for demolition and removal of existing asphalt pavement.
3. Section 31 20 00 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
4. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

1.2 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.
2. Include technical data and tested physical and performance properties.
3. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

B. Informational Submittals:

1. Qualification Data: For manufacturer.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of applicable standards indicated on Civil Drawings for asphalt paving work.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

B. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.

2. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.

2. Tack Coat: Minimum surface temperature of 60 deg F.

3. Slurry Coat: Comply with weather limitations in ASTM D 3910.

4. Asphalt Base Course: Minimum surface temperature of 40 deg Fand rising at time of placement.

5. Asphalt Surface Course: Minimum surface temperature of 60 deg Fat time of placement.

PART 2 - PRODUCTS

2.1 ASPHALT MATERIALS

A. Performance Grade Asphalt Binder: Petroleum asphalt that complies with ASTM D6373. Blend with polymers or natural asphalts at CONTRACTOR’s discretion.

B. Asphalt Cement: ASTM D 3381/D 3381M for viscosity-graded material.

2.2 AUXILIARY MATERIALS

A. LEEDv4 - Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires asphalt shingles or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

2.3 MIXES

A. LEEDv4 - Recycled Content of Hot-Mix Asphalt: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 20 percent or more than 25 percent by weight.

1. Surface Course Limit: Recycled content no more than 10 percent by weight.

B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

2. Base Course: As indicated on Civil Drawings.

3. Surface Course: As indicated on Civil Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by ENGINEER, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.

2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.

3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints as shown on Drawings.

5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.3 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent or greater than 100 percent.

2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

A. Acceptance: A lot is acceptable if density tests are within pay factor 1.00 limits. At ENGINEER's discretion, a Lot with deficient sub-lot density tests may be accepted if pay is adjusted using an acceptable pay factor in the flowable table, or accepted at 50 percent pay if a sub-lot is in in Reject.

Table 1 – Compaction Pay Factors		
Pay Factor	**Density, in Percent Relative to ASTM D2041**	
	Average	**Lowest Test**
0.70	More than 96	--
1.00	**92 to 96**	**89 or greater**
0.90	92 to 96	Less than 89
0.80	Less than 92	89 or greater
Reject	Less than 92	Less than 89

3.4 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus, or minus 1/2 inch.

2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.

2. Surface Course: 1/8 inch.

3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.5 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 01 74 19 "Construction Waste Management and Disposal."

END OF SECTION

SECTION 32 13 13

CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Comply with provisions indicated on Civil Drawings and with the additional provisions specified in this Section.

B. Related Section:

1. Section 01 60 01 "Buy America Requirements" for special product requirements.

2. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

3. Section 32 17 23 "Pavement Markings."

4. Section 03 30 00 “Cast in Place Concrete.”

1.2 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.

2. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

3. Before delivery: Submit 48 hours before delivery:

a. Traffic control plan, Section 01 55 26 “Traffic Control.”

b. Joint layout plan.

c. Concrete placement plan. Identify items such as but not limited to grade control system, placement start and stop timing, hydration control during cold conditions (ACI 306), hot and windy conditions (ACI 305), timing for evaporation retarder application, timing for curing agent application, floating restrictions, concrete saw-cut timing, header joints.

d. Curing plan. Describe method to prevent excessive concrete temperatures and water evaporation that could impair strength or serviceability of concrete. Refer to ACI 305.

e. Evaporation Retarder Data Sheet. Identify product components, application, and manufacturer's recommendations.

f. Proof of finisher's ACI certification.

g. Make and model name of paving machine, grade trimmer, and gang drill mechanism.

h. Pre-approved concrete mix design or supplier's mix number, Section 03 30 00 "Cast in Place Concrete."

i. Manufacturer's recommended installation procedures for joint sealing material which, when accepted by ENGINEER will become the basis for accepting or rejecting actual installation procedures used in the work.

4. At Delivery: Submit batch ticket, Section 03 30 10 "Concrete Placement."

5. After Placement: Before final payment submit summary report describing profile deviation and profile roughness. See Section 32 01 31 "Pavement Smoothness" requirements.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.7 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

a. Concrete mixture design.

b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

a. Independent testing agency responsible for concrete design mixtures.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.

2. Do not use frozen materials or materials containing ice or snow.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

4. Provide weather protection until 90 percent of design compressive strength is achieved.

C. Hot-Weather Concrete Placement: Comply with ACI 305 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is CONTRACTOR’s option.

2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

4. Set retarding admixture may be used if allowed in mix design. Discontinue placement if ambient air temperature exceeds 100 deg F in the shade.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301, 305, 306, and 318 unless otherwise indicated.

2.2 MIX DESIGN

A. Compressive Strength: Class 4000, section 03 30 00.

B. Flexure Design:

1. Strength: 650 psi, ASTM C78.

2. Cement Content: 6.5 bags.

3. Water cement Ratio: 0.44 maximum by weight (before pozzolan exchange), ACI 318.

4. Entrained Air: Five (5) to seven (7) percent, ASTM C231 (pressure).

5. Slump per accepted mix design.

2.3 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.

2.4 CONCRETE MATERIALS

A. Evaporation Retarder:

1. Water based spray-on liquid that forms a mono-molecular film over the plastic concrete surface.

B. Concrete curing compound.

1. Type II Class A or B (white pigmented) liquid membrane forming compound, ASTM C1315.

C. Joint material.

1. Section 32 13 73 “Concrete Paving Joint Sealants.”

a. Expansion Joint Filler: F1 sheet.

b. Contraction Joint Filler (Backer Rod): Type 1 round, ASTM D5249.

c. Contraction Joint Sealer: HAS1, HAS4, or CAS6.

D. Steel reinforcement.

1. Section 03 20 00 “Concrete Reinforcing.”

2. Tie Bar: Grade 60 or higher deformed billet steel bars galvanized, or epoxy coated.

3. Dowel Bar: Grade 60 or higher billet steel bar, galvanized, or epoxy coated with plastic expansion cap on one (1) end.

4. Chair and Basket Assemblies: Plastic chairs. Galvanized or epoxy coated grade 60 billet steel bar basket assemblies.

5. Hook Bolts: Galvanized ASTM A307, grade A steel, nuts and shaft internal and externally threaded.

E. Bond breaker.

1. Wax based compound.

F. Epoxy adhesive.

1. Two component, Section 03 61 00 “Cementitious Grouting”

G. Evaporative reducer.

1. Water-based mono-molecular polymer liquid at application rates recommended by manufacturer. DO NOT use as a finishing aid.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.

2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 31 20 00 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

B. Notify ENGINEER at least 24 hours before commencement of concreting operations.

C. Verify base course is placed to grade, compacted, and dampened.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

   1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

   1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

K. Reinforcement placement.

1. Install reinforcement per Section 03 20 00 “Concrete Reinforcing.”

2. Use smooth dowel in expansion joints.

3. Interrupt reinforcement placement at expansion joints.

4. Keep load transfer bars and dowels in vertical center of concrete and perpendicular to the joint during concrete placement.

5. Position mats on bar chair supports and properly tie before concrete is poured. Keep mats clean, free from rust, flat, and free of distortions. Straighten bends, kinks, and other irregularities or replace units before concrete placement. Provide at least two (2) inch overlap to adjacent mats.

6. Dowel Bars: Place dowel bars perpendicularly at contraction and expansion joints, ensuring the ends are embedded securely within the concrete. Avoid placing the ends of dowel bars within 18 inches of any longitudinal joint to maintain structural integrity.

7. Tie bars: Place tie bars at longitudinal joints to ensure proper load transfer. Avoid placing the ends of tie bars within 18 inches of any transverse joint to prevent weakening of the pavement structure.

3.5 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

3.6 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.

2. Thickness: Plus 3/8 inch, minus 1/4 inch.

3. Surface: Gap below 10-feet- long; unleveled straightedge not to exceed 1/2 inch.

4. Joint Spacing: 3 inches.

5. Joint Width: Plus 1/8 inch, no minus.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain set of four cylinders per 100 cubic yards of each concrete placed each day.

2. Slump: ASTM C 143/C 143M; one set at placement for each composite sample, but not less than one set for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture. Same time and frequency as cylinders.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 400 psi.

D. Test results shall be reported in writing to ENGINEER, concrete manufacturer, and CONTRACTOR within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by ENGINEER but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by ENGINEER.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at ENGINEER's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

J. Strength Pay Factor.

1. At ENGINEER's discretion, a Lot with deficient sub-lot strength may be accepted if pay is adjusted using of the following applicable pay factors, or accepted 50 percent pay if a sub-lot is in Reject. Use the average of compressive strength test for Table 1 below:

Table 1 - Strength Pay Factor

Criteria	Pay Factor	PSI Below 28-day Compressive Strength	Lot Size, in Square Yards
Compression (ASTM C39)	0.98	1 to 100	500
	0.94	101 to 200	
	0.88	201 to 300	
	0.80	301 to 400	
	Reject	Greater than 400	
Flexure (ASTM C78)	0.95	1 to 29	750
	0.85	30 to 60	
	Reject	Greater than 60	

3.8 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by ENGINEER.

B. Drill test cores, where directed by ENGINEER, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 13 73

CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints and joint sealants in horizontal concrete sidewalks, curb, gutter and roadway Pavement surfaces.

1.2 REFERENCES

A. ASTM Standards:

1. C920 Elastomeric Joint Sealants.
2. D545 Preformed Expansion Joint Fillers for Concrete Construction (Nonextruding and Resilient Types).
3. D994 Preformed Expansion Joint Filler for Concrete (Bituminous Type).
4. D1190 Concrete Joint Sealer, Hot-Poured Elastic Type.
5. D1191 Testing Concrete Joint Sealers.
6. D1751 Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
7. D1752 Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
8. D1851 Concrete Joint Sealers, Cold-Application Type.
9. D2240 Rubber Property - Durometer Hardness.
10. D2628 Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.
11. D3405 Joint Sealants, Hot-Poured, For Concrete and Asphalt Pavements.
12. D3406 Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements.
13. D3407 Testing Joint Sealants, Hot-Poured, For Concrete and Asphalt Pavements.
14. D3408 Joint Sealants, Hot-Poured, Elastomeric-Type, for Portland Cement Concrete Pavements.
15. D3542 Preformed Polychloroprene Elastomeric Joint Seals for Bridges.

16. D3569 Joint Sealant, Hot-Applied, Elastomeric, Jet-Fuel-Resistant-Type for Portland Cement Concrete Pavements.

17. D3575 Flexible Cellular Materials Made from Olefin Polymers.

18. D3581 Joint Sealant, Hot-Poured, Jet-Fuel-Resistant Type, for Portland Cement Concrete and Tar-Concrete Pavements.

19. D3582 Testing Joint Sealant, Hot-Poured, Jet-Fuel-Resistant Type, for Portland Cement Concrete and Tar-Concrete Pavements.

20. D3583 Joint Sealant, Hot-Applied, Elastomeric Type, for Portland Cement Concrete Pavements, or Joint Sealant, Hot Applied, Elastomeric, Jet Fuel Resistant Type, for Portland Cement Concrete Pavements.

21. D5249 Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement and Asphalt Joints.

22. D5893 Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.

B. FS Standards:

1. SS-S-200 Sealants, Joint, Two Component, Jet-Fuel Resistant, Cold-Applied, for Portland Cement Concrete Pavement.

1.3 SUBMITTALS

A. Manufacturer's certification that product was manufactured, tested and supplied meeting source quality control requirements specified herein, together with a report of the test results and the date each test was completed.

B. Manufacturer's instruction for joint preparation, type of cleaning and installation.

C. Manufacturer's product data and samples for each joint sealant product required.

D. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch-wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

E. Safety data sheets.

1.4 QUALITY ASSURANCE

A. Installation of joint systems are to follow manufacturer’s published directions.

B. For cold applied joint sealant installation, use installers approved by joint sealant supplier.

C. Obtain joint sealing materials from a single manufacturer for each different product required.

D. A mock-up test should be conducted to evaluate the joint sealant's performance. The test should include all types of joints for sealant application.

E. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance for a minimum of 5-years.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 SYSTEM PERFORMANCES

A. Pavement joints include longitudinal and transverse expansion joints, contraction joints, construction joints, and crack control joints.

B. Provide joint sealants that maintain watertight and airtight continuous seals.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in original unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, cure time, and mixing instructions for multi-component materials.

B. Store and handle materials in compliance with manufacturer's recommendations to prevent deterioration; or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.8 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.

2. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (4.4 deg C).

3. When joint substrates are wet or covered with frost.

4. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

5. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 GENERAL

A. Compatibility: Provide joint fillers, sealant backings, sealants, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by ENGINEER from manufacturer's full range.

2.2 JOINT VOID – FORMER

A. Plastic with a water stop.

B. 1/4 depth of concrete structural section.

2.3 JOINT FILLER - SHEET TYPE

A. F-1: Bituminous (asphalt or tar) mastic, ASTM D994. Formed and encased between two (2) layers of bituminous saturated felt or two (2) layers of glass-fiber felt.

B. F-2: Cane or other cellulosic fiber, ASTM D1751. Saturated with asphalt.

C. F-3: Granulated cork, ASTM D1751. In an Asphalt Binder; encased between two (2) layers of asphalt saturated felt or two (2) layers of glass-fiber felt.

D. F-4: Sponge rubber fully compressible, ASTM C1752. With resiliency recovery rate of 90 percent minimum.

E. F-5: Cork, ASTM C1752. Impregnated and bound with asphalt, compressible with resiliency recovery rate of 90 percent if not compressed more than 50 percent of original thickness.

F. F-6: Plastic foam (for cold-applied sealants only). Preformed, compressible, resilient, non-waxing, non-extruding strips of flexible, non-gassing plastic foam; non-absorbent to water and gas; 30 pounds per cubic foot density maximum, And of size and shape to control sealant depth and performance.

2.4 JOINT FILLER - BACKER ROD, TAPE, POURED FILL TYPE

A. Backer material, ASTM D5249 for cold-applied and hot-applied joint sealant in Portland cement concrete or bituminous concrete pavements joints:

1. Type 1: Round rods.

2. Type 2: Sheets or strips, laminated or skived.

3. Type 3: Poured fills that completely fills pavement joint.

2.5 JOINT SEALANT – HOT APPLIED

A. HAS-1: Asphalt base type, ASTM D3405.

B. HAS-2: Thermoplastic type, ASTM D3581. Jet-fuel resistant without rubber unless indicated otherwise.

C. HAS-3: Elastic type, ASTM D1190.

D. HAS-4: Elastomeric type, ASTM D3406. One component, for Portland cement concrete pavements.

E. HAS-5: Elastomeric type, ASTM D3569. One component, jet-fuel resistant, for Portland cement concrete pavements.

F. For each sealant type used, provide a primer that is recommended by the sealant manufacturer and that complies with VOC limits of authorities having jurisdiction.

2.6 JOINT SEALANT – COLD APPLIED

A. CAS-1: Elastomeric type, ASTM C920. Chemically curing, for vehicular or pedestrian use, and types of construction other than highway and airfield pavements and bridges and joint substrates indicated; Type S or M; Grade P or NS; Class 25; Use T, NT, M and O:

1. Self leveling.

2. Shore A Hardness, ASTM D2240: 40 plus or minus 5.

3. Final cure: Four (4) days maximum.

4. Service range: -10 to 150 deg F.

B. CAS-2: Mastic type, ASTM D1851. Single or multiple component; for joints having a minimum width of 1/2 inch.

C. CAS-3: Coal-tar modified urethane, FS SS-S-200. One part, jet fuel resistant; Type H.

D. CAS-4: Elastomeric preformed polychloroprene type with lubricant adhesive and indicated movement ratio:

1. For concrete pavement seal, ASTM D2628.

2. For concrete bridge seals, ASTM D3542.

E. CAS-5: Silicone type, ASTM D5893. Single component, non-sag or self leveling, chemically curing sealant based on polymers of polysiloxane structure intended for use in Portland cement concrete pavements.

F. CAS-6: Asphalt base meeting ASTM D3405.

G. CAS-7: Olefin polymer, ASTM D3575 as follows:

1. Tensile elongation 255 percent plus or minus 20 percent, Suffix T.

2. Tensile strength 115 psi minimum, Suffix T.

3. Density 2.9 plus or minus three (3) lbs/cubic foot, Suffix W, Method A.

4. Water absorption 0.025 lbs/square foot maximum, Suffix L.

2.7 SOURCE QUALITY CONTROL

A. Preformed Expansion Joint Fillers: Non-extruding and resilient types, ASTM D545.

B. Hot-Applied Joint Sealants:

1. Elastic type used in concrete pavements, bridges, other structures, ASTM D1191.

2. Bituminous type for Portland cement concrete and bituminous concrete pavements, ASTM D3407.

3. Elastomeric type for hydraulic concrete pavement, ASTM D3408.

C. Jet-Fuel-Resistant Joint Sealant: Hot applied, ASTM D3582 and ASTM D3583.

D. Cold-Applied Mastic Joint Sealant: Cold applied, ASTM D1851.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove oil, grease, wax, form-release-agents, curing compounds, bitumens, laitance and old chalking material by sandblast, or water blast as recommended by manufacturer of sealant. Maximum sand blast angle, 25 degrees plus or minus five (5) degrees.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Clean and dry with air blast. Do not contaminate air blast with oils or lubricants.

C. Remove frost and moisture in concrete joint substrates before commencing sealing.

D. Install bond breaker tape where needed or required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.

E. Conduct adhesion testing to ensure compatibility between substrate, primer, and sealant.

3.2 JOINT SEALING

A. General:

1. Install sealants in uniform, continuous ribbons without gaps or air pockets, with complete bonding of joint surfaces on opposite sides.

2. Except as otherwise indicated, fill sealant rabbet flush with surface.

3. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.

B. Depths: Saw cut joints if necessary to provide the required sealant thickness and depth. Install sealant to depths indicated or, if not indicated, as recommended by sealant manufacturer, but within the following general limitations measured at center (thin) section of bead:

   1. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but not more than 5/8 inch deep nor less than 3/8 inch deep.

   2. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2 inch deep nor less than 1/4 inch deep.

   3. For joints sealed with non-elastomeric sealants and caulking compounds, fill joints full depth.

C. Spillage: Do not allow poured sealant compound to overflow or spill onto adjoining surfaces or to migrate into voids of adjoining surfaces. Clean adjoining surfaces to eliminate evidence of spillage.

D. Heating: Do not use overheated hot-applied sealants.

E. Edges: Unless indicated otherwise, recess exposed edges of gasket and exposed joint fillers slightly behind adjoining surfaces so compressed units will not protrude from joints.

F. Joint-Width-to-Depth Ratio: Install backer rod and use other methods to achieve the following standard joint-width-to-depth ratio, unless otherwise indicated by manufacturer's written instructions.

3.3 CURING AND CLEANING

A. Cure sealants and caulking compounds per manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength and surface durability.

B. Clean off excess sealants or sealant smears adjacent to joints as work progresses. Use methods and cleaning materials approved by manufacturers of joint sealant and of products in which joints occur.

C. Clean joints and prepare surfaces in accordance with the sealant manufacturer's written instructions for each particular substrate condition.

D. Remove protective coating and oil from metals with solvent recommended by the sealant manufacturer.

3.4 PROTECTION

A. Protect joint sealant during and after curing period from contact with contaminating substances or from damage resulting from deterioration or damage at time of substantial completion.

B. If damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealant immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work at no additional cost to OWNER.

C. Protect joint sealants during the remainder of the construction period, to prevent puncture, abrasion, or other damage. If, despite such protection, damage occurs, cut out and remove damaged joint sealants immediately so that a complete joint seal system can be reinstalled.

END OF SECTION

SECTION 32 14 13

PRECAST CONCRETE UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mortarless interlocking concrete pavers for sidewalks, roadways, and similar paving.

1.2 REFERENCES

A. ASTM Standards:

1. C33 Concrete Aggregates.
2. C67 Sampling and Testing Brick and Structural Clay Tile.
3. C136 Sieve Analysis for Fine and Coarse Aggregates.
4. C140 Sampling and Testing Concrete Masonry Units.
5. C144 Aggregate for Masonry Mortar.
6. C150 Portland Cement.
7. C936 Solid Interlocking Concrete Paving Units.
8. C979 Coloring Agents for Concrete.
9. D1557 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using a 10 lb (4.54-kg) Rammer and a 19-In. (457-mm) Drop.
10. D3785 Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics Diaphragm Bursting Strength Tester Method.
11. D4751 Determining Apparent Opening Size for a Geotextile.

B. ICPI Standards.

1.3 SUBMITTALS

A. Data sheets:

1. Bedding sand gradation.
2. Joint sand gradation.
3. Joint sand stabilizer.
4. Paver strength and absorption. Test results not older than 365 days.

B. Certification that paver unit complies with ASTM C936.

1.4 QUALITY ASSURANCE

A. Installer:

1. Certified by, and knowledgeable of Interlocking Concrete Pavement Institute (ICPI) technical bulletins.

2. Completed at least three (3) unit paver applications of similar size and scope.

3. Will assign installer from earlier applications to the work of which one will serve as lead installer.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PRODUCT HANDLING

A. Protect unit pavers against soilage. Protect sand against intermixture with earth or other types of materials.

B. Remove damaged pavers.

PART 2 - PRODUCTS

2.1 CONCRETE PAVERS

A. Solid Interlocking units with spacer bars, ASTM C936:

1. Cement: ASTM C150 hydraulic cement.

2. Aggregates: Sand and natural aggregates (washed and graded with no expanded shale or light weight aggregates), ASTM C33.

3. Average Compressive Strength: Greater than 8,000 psi with no individual unit test less than 7,200 psi.

4. Average Absorption: Less than five (5) percent with no individual unit greater than seven (7) percent, ASTM C140.

5. Freeze-Thaw: Resistance to 50 cycles, ASTM C67.

6. Efflorescence Prevention: Admixture per recommendation of manufacturer.

B. Shape: 200 mm x 100 mm unless specified elsewhere.

C. Thickness:

1. Sidewalks: 60 mm.

2. Roadways: 80 mm.

3. Crosswalks: 80 mm.

4. Driveway Approaches: 80 mm.

D. Color: Reddish brown using an inorganic mineral oxide.

2.2 BEDDING AND JOINT SAND

A. Clean, non-plastic, naturally occurring silica sand conforming to ASTM C33 or ASTM C144, with no more than five (5) percent acid soluble material.

B. Gradation: Analyzed according to ASTM C136 on a dry weight and percent passing basis. Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum.

Table 1 – Bedding and Joint Sand Grading Bands

Sieve	Bedding Sand	Joint Sand
	ASTM C33	ASTM C144
3/8 inch	100	--
No. 4	95 to100	100
No. 8	80 to 100	95 to 100
No. 16	50 to 85	50 to 100
No. 30	25 to 60	40 to 100
No. 50	5 to 30	20 to 40
No. 100	0 to 10	10 to 25
No. 200	--	0 to 10

2.3 JOINT SAND STABILIZER

A. Water based polymer sealer capable of penetrating the joint sand to a depth of 1/2 inch before polymerization.

B. No significant discoloration.

C. No significant static coefficient of friction reduction.

2.4 GEOTEXTILE FILTER FABRIC

A. Non-woven with the following properties:

1. Apparent Opening Size (OAS): 70 sieve, ASTM D4751.

2. Puncture: 65 lbs minimum, ASTM D3786.

3. Thickness: 60 mils average.

B. Consult fabric manufacturer if:

1. Subgrade CBR less than 2, or
2. Surfaces are subject to highway or industrial loads.

2.5 SOURCE QUALITY CONTROL

A. ICPI member manufacturer.

B. Concrete masonry units, ASTM C140.

PART 3 - EXECUTION

3.1 PREPARATION

A. Environment:

1. Do not build on saturated or frozen subgrade or setting beds.
2. Do not install pavers during heavy rain or snowfall.

B. Pavers on soil base:

1. Soil base surface tolerance is 3/8 inch in 10 feet and sloped to drain.
2. Compaction is 95 percent or greater relative to a modified proctor density, Section 31 23 26 “Compaction.”

C. Pavers on concrete base:

1. Concrete surface is free from hydrostatic pressure and moisture content is less than five (5) percent.
2. Weep holes:
   a. 2 inch diameter.
   b. At lowest elevations against curbs, walls, or other permanent structure.
   c. Filled with washed pea gravel and covered over with geotextile.

D. Layout:

1. Verify Subgrade is compacted, ready to receive substrate materials, and is sloped to drain.
2. Check final elevations and patterns for conformance to drawings.

3.2 INSTALLATION

A. Concrete Base Preparation:

1. Sweep the surface clean.
2. Fill any cracks under 3/16 inches wide with mortar.

B. Bedding Sand:

1. Place and screed allowing for paver height and compaction.
2. After screeding, do not disturb or compact. Fill screed rails voids with loose sand.
3. Remove all compressions in the bedding sand.
4. Remove from bedding sand any concrete dust or waste from the paver cutting operation.

C. Cutting Pavers:

1. Point up joints to provide a neat, uniform appearance.
2. Minimum cut length is 3/4 paver, or 1/2 paver providing adjacent paver is also reduced no more than 1/2 its original length.
3. Cut vertical faces with masonry saw.
4. No chipping or breaking for shaping.
5. No modification of top or bottom face of paver.

D. Pavers:

1. Do not install paver over saturated or dry sand. Sand should be damp.
2. Paver surface to be 1/8 to 3/16 inch above grade or edge restraints after compaction.
3. Keep paver lines straight, true, and square.
4. Use a low amplitude, high frequency plate vibrator capable of at least 5,000 lbf (pound force) at a frequency of 75 hz to 10 hz.
5. Do not vibrate within six (6) feet of an unrestrained edge of pavers.

E. Control and Structural Joints:

1. Extend control and structural joints through full depth of paving units.
2. Install joints at all building facades or other vertical surfaces.

F. Joints Between Paver Units:

1. 1.5 to 4 mm.
2. Maximum 50 percent between 2mm-3mm and 10 percent between 3mm-4mm in any three (3) feet square area.

G. Joint Sand and Stabilizer:

1. After setting pavers, sweep joint sand into joints and vibrate again until joins are full.

2. Bedding sand may be used for joint sand, however, extra effort in sweeping and compacting the pavers may be required in order to completely fill the joints.

3. After final vibration remove excess sand and debris.

4. Apply joint sand stabilizer within 1 week of installing joint sand.

3.3 TOLERANCES

A. Lippage: 1/16 inch maximum elevation difference unit to unit.

B. Cross Slope: 1/8 inch in 10 feet.

C. Longitudinal:

1. Sidewalks: 1/8 inch in 10 feet.

2. Roadway:

a. 1/8 inch in 10 feet parallel to centerline.

b. 1/4 inch in 10 feet perpendicular to centerline except at cross section grade breaks.

D. Drainage Inlets, Concrete Collars or Channels: Paver is 1/8 inch to 1/4 inch higher.

3.4 PROTECTION AND REPAIR

A. Provide final protection and maintain conditions in a manner acceptable to installer.

B. Repair:

1. Remove and replace non-matching pavers or pavers which are chipped, broken, stained or otherwise damaged. Fill joints with joint sand and compact with plate compactor.

2. Remove excess sand.

END OF SECTION

SECTION 32 14 16

BRICK UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Handling and installation procedures for paving brick.
2. Material requirements and tolerances.

1.2 REFERENCES

A. ASTM Standards:

1. C33 Concrete Aggregates.
2. C144 Aggregate for Masonry Mortar.
3. C150 Portland Cement.
4. C207 Hydrated Lime for Masonry Purposes.
5. C902 Pedestrian and Light Traffic Paving Brick.

B. BIA Standards.

1.3 SUBMITTALS

A. Test Reports: Submit control testing reports as requested verifying compliance with specified standards.

B. Brick Samples: Before commencing work, obtain approval of representative samples of the brick specified.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PRODUCT HANDLING

A. Handle and store paving brick in a manner to avoid chipping, breakage, intrusion of foreign matter, and staining.

B. Handle, store, mix and apply proprietary setting and grouting materials in strict compliance with the manufacturer’s instructions.

C. Take precautions to protect the mortar and grout admixtures from freezing or from excessive heat.

PART 2 - PRODUCTS

2.1 PAVING BRICK

A. ASTM C902 classification Type SX (freeze resistant), Traffic Type 1 (extensive abrasion), application PX (without mortar joints) unless indicated otherwise:

1. Nominal Size:

a. 3-5/8 inches x 7-5/8 inches x 2 inches for roadway or driveway areas.

b. 3-5/8 inches x 7-5/8 inches x 1 inch for sidewalk areas.

2. Color: Reddish brown if not elsewhere specified.

3. Friction Test: 0.5 minimum for wet leather and wet brick.

2.2 MORTAR AND GROUT

A. Mixture of water, ASTM C150 type I Portland cement, ASTM C207 type S lime, ASTM C144 mason's sand, ASTM C33 concrete sand to provide the following:

1. Compressive Strength:

a. Thick bed mortar, 3,000 psi minimum.

b. Thin bed, bonding, grouting mortars, 5,000 psi minimum.

2. Tensile Strength: Thin bed, bonding, grouting mortars, 500 psi minimum.

3. Bond Strength: Thin bed, bonding, grouting mortars, 500 psi minimum.

4. Water Absorption: 4.0 percent maximum.

5. Ozone Resistance: 200 hours at 200 ppm. No loss of strength.

6. Smoke Contribution Factor: 0.

7. Flame Contribution Factor: 0.

B. Resistant to urine, dilute acid, dilute alkali, sugar, brine, and food waste products.

C. Additives compatible from one manufacturer, non-toxic, non-flammable, and non-hazardous during storage, mixing, application, and when cured. The addition of water or other materials to dilute the mortar additive on the job site will not be permitted.

2.3 REINFORCING MESH

A. 6 x 6 x 10 gage galvanized welded wire mesh, Section 03 20 00 "Concrete Reinforcing."

2.4 WATER REPELLANT

A. Penetrating compound, Section 07 19 00 “Water Repellent.”

2.5 JOINT SEALING COMPOUND

A. CAS1 polyurethane, Section 32 13 73 “Concrete Paving Joint Sealants” unless indicated otherwise.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect surfaces scheduled to receive brick paving for:

1. Defects that will affect the execution and quality of work.

2. Deviations beyond allowable tolerances over the substrate.

B. Correct unsatisfactory conditions.

3.2 PREPARATION

A. Clean surfaces as required to remove materials that will affect installation.

B. Place concrete base to nominal finish grade (minus paving brick thickness and setting bed mortar).

C. Wet cure concrete base. Remove curing compounds by sandblast before placing setting bed mortar.

3.3 INSTALLATION

A. Install per ANSI and BIA recommendations.

B. Cut units with powered masonry saw.

C. Lay units out so fields or patterns center in areas.

D. Lay units out to minimize pieces smaller than 1/2 brick.

E. Set units into setting bed while mortar is still plastic or set into thin set mortar over prepared setting bed.

F. Tap each unit firmly into place to assure full adhesion.

G. Set units with nominal 3/8 inch joints between units.

H. Force grout between units to fill joints completely.

I. Remove surplus grout and leave faces clean.

J. Flood brick paving to determine any areas of standing water. Remove and replace any area where ponding is found.

K. Provide sealant joints where brick abuts vertical surfaces, around penetrations, and over expansion or control joints where indicated.

L. Apply surface sealer per manufacturer's recommendation.

3.4 TOLERANCES

A. For finish surface of paving, do not exceed 1/16 inch unit to unit offset to flush, and a tolerance of 1/8 inch in two (2) feet and 1/4 inch in 10 feet from level or slope indicated.

3.5 PROTECTION

A. Protect installed pavers from damage.

B. Do not allow vehicular traffic on brick paving for 14 days or until the mortar and underlying concrete has reached a strength of 3,000 psi.

C. Provide alternate access to adjacent properties.

3.6 CLEANING

A. Remove protective coverings.

B. Clean entire surface with cleaning compound.

C. Protect adjacent surfaces from damage due to cleaning operations.

END OF SECTION

SECTION 32 16 13

DRIVEWAY, SIDEWALK, CURB, GUTTER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete flat work such as waterways, waterway transition structures, sidewalks, curb, gutters, Driveway Approaches, etc.

1.2 REFERENCES

A. APWA (Utah) Standards:

1. Plan 205 Curb and gutter.
2. Plan 206 Curb and gutter dowel tie-in.
3. Plan 209 Curbs.
4. Plan 211 Waterway.
5. Plan 213 Waterway transition structure.
6. Plan 215 Dip driveway approach.
7. Plan 216 Mountable curb driveway approach.
8. Plan 221 Flare driveway approach.
9. Plan 225 Open driveway approach.
10. Plan 229 Pipe driveway approach.
11. Plan 231 Concrete sidewalk.

B. ASTM Standards:

1. A36 Structural Steel.
2. C39 Compressive Strength of Cylindrical Concrete Specimens.
3. C172 Sampling Freshly Mixed Concrete.

1.3 SUBMITTALS

A. Traffic control plan, Section 01 55 26 “Traffic Control.”

B. Concrete mix design, Section 03 30 00 “Cast in Place Concrete.”

C. Batch ticket, Section 03 30 10 “Concrete Placement.”

D. Utility marking plan, in accordance with Section 01 31 13 “Utility Locating.”

1.4 QUALITY ASSURANCE

A. If requested, submit a quality control and testing report describing source and field quality assurance activities performed by CONTRACTOR and Suppliers.

1.5 ACCEPTANCE

A. General:

1. Acceptance is by lot. One lot is one day production.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring material as part of its installation, Section 01 29 00 “Payment Procedures.”

3. Dispute resolution, Section 01 35 10 and Section 03 30 05 “Concrete Testing.”

B. Concrete Mix:

1. Testing Frequency: Section 03 30 05 “Concrete Testing.” Sample per ASTM C172.

2. Temperature, Slump, Air: Lot size is 1 random batch. Reject non- complying batches until two (2) consecutive batches are compliant then proceed in random batch testing for acceptance.

3. Strength: Lot size is 50 cubic yards. At ENGINEER’s discretion and ASTM C39, a lot with deficient sub-lot strength may be accepted if pay is adjusted using one of the following applicable pay factors, or accepted at 50 percent pay if a sub-lot is in Reject.

PSI Below 28 days Compressive Strength	Pay Factor
1 to 100	0.98
101 to 200	0.94
201 to 300	0.88
301 to 400	0.80
Greater than 400	Reject

C. Placement, Section 03 30 10 “Concrete Placement”:

1. Verify line, grade, cross slope, finish, and dimensions.

2. No standing water in curb and gutter.

3. Membrane curing compound applied for total coverage at two (2) times manufacturer’s recommended rate in two (2) directions after finishing and texturing.

1.6 DEFINITIONS

A. Driveway: A paved or unpaved vehicular thoroughfare outside of, but connected to a public road right-of-way or highway right-of-way.

B. Driveway Approach: A paved or unpaved vehicular thoroughfare connecting a public road or highway to a Driveway.

1.7 NOTICE

A. Follow Laws and Regulations concerning when and to whom notices are to be given at least two (2) days before work starts.

B. Indicate when concrete work will take place and when driveway approach can be used.

C. Warn of potential vehicle tow away and other construction issues affecting neighborhood.

D. Should work not occur on specified day, send a new notice.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete Mix:

1. Class 4000 cast-in-place, Section 03 30 00 “Cast in Place Concrete.”

2. Slump range per mix design.

B. Reinforcement: Grade 60 ksi galvanized or epoxy coated steel, Section 03 20 00 “Concrete Reinforcing”, deformed.

C. Expansion Joint Filler: F1 sheet 1/2 inch thick, Section 32 13 73 “Concrete Paving Joint Sealants.”

D. Contraction Joint Filler (Backer Rod): Closed cell, Type 1 round, Section 32 13 73 “Concrete Paving Joint Sealants.”

E. Contraction Joint Sealer: HAS1 or HAS4 hot applied, Section 32 13 73 “Concrete Paving Joint Sealants.”

F. Curing Compound: Membrane forming compound, Section 03 39 00 “Concrete Curing.”

G. Plate Steel: Galvanized Steel, ASTM A36, Section 05 05 10.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Slip Form Machines:

1. Placement must produce required cross-section, line, grade, finish, and jointing as specified for formed concrete.

2. If results are not acceptable, remove and replace work with formed concrete.

3.2 PREPARATION

A. Implement notification and traffic control plan requirements, Section 01 55 26 “Traffic Control.”

B. Examine surfaces scheduled to receive concrete formwork for defects.

C. Do not start work until defects are corrected.

D. Check slopes on each side of the work to ensure drainage. Failure to check and verify will result in CONTRACTOR repairing any drainage deficiencies at no additional cost to OWNER.

E. Identify utility lines, such as water, sewer, electricity, and telecommunications, according to the utility marking plan.

3.3 CONCRETE PLACEMENT

A. Place concrete per Section 03 30 10 “Concrete Placement.”

B. Make sure base course is uniformly damp at time of concrete placement.

C. Obtain ENGINEER’s review of base course and forms before placing concrete.

D. Do not use methods that segregate the mix.

E. Place concrete so time between end of placement and beginning of finishing is less than 15 minutes.

F. Consolidate concrete with vibrator or other acceptable method. Do not use mechanical vibrators. Prevent dislocation of inserts.

3.4 CONTRACTION JOINTS

A. Install joint sealants per, Section 32 13 73 “Concrete Paving Joint Sealants” unless directed otherwise in this Section.

B. Geometrics:

1. Tooled Joints (Score Lines):

a. Depth = T/4. T is the depth of the concrete slab in inches.

b. Top radius = 1/2 inch.

2. Saw Cut Joints: Saw joints before uncontrolled shrinkage cracking occurs. Do not tear or ravel concrete during sawing.

3. Template Joints: 1/8 to 3/16 inch wide 1/4-depth of slab.

C. Sidewalks.

1. At intervals equal to the width of the sidewalk and transverse to the line of walk.

2. Radial at curbs and walk returns.

3. Place longitudinal joints in walks when width of walk in feet is greater than two (2) times the walk thickness in inches. (e.g. maximum width of a four (4) inch thick walk before placement of a longitudinal contraction joint is eight (8) feet). Make longitudinal joints parallel to, or concentric with, the lines of the walk.

4. In walk returns make at least one (1) radial joint midway between beginning of curb returns (BCR) and end of curb returns (ECR). Match longitudinal and traverse joints with joints in adjacent walks.

D. Curb, Gutter, Waterway:

1. Place joints at intervals not exceeding 12 feet.

2. At curb radius and walk returns make joints radial.

3. Where integral curb and gutter is adjacent to concrete pavement, align joints with pavement joints where practical.

3.5 EXPANSION JOINTS

A. General: Section 32 13 73 “Concrete Paving Joint Sealants”:

1. 1/2 inch wide full depth filler that is flush with concrete surface. Do not place seal over top of joint filler.

B. Sidewalks:

1. Place expansion joints to separate sidewalk from utility poles, hydrants, manhole frames, buildings and abutting sidewalks.

2. Place expansion joints between sidewalk and back of curb returns and between sidewalk and sidewalk ramps.

3. Do not place expansion joints in sidewalk ramp surfaces.

4. Expansion joints are not required when using slip form method to place concrete except where sidewalk changes direction or where it joins foundation walls or structures.

C. Curb, Gutter, Waterway:

1. Do not place longitudinal joint in drain gutter flow-line.

2. Where drain gutter transitions extend beyond curb return, place expansion joints at ends of drain gutter transition.

3. Place expansion joints at beginning of curb radius (BCR) and at end of curb radius (ECR).

D. Curb and Gutter Dowel Tie-in: Follow APWA Plan 206 requirements. Tie-in occurs between new and existing curb and gutter.

E. Slip Form Work: Expansion joints are not required except at BCR or ECR.

F. Driveway Approach: Do not place expansion joints in curb returns.

G. Street Intersection Corner: Place expansion joints at BCR and ECR.

3.6 FINISH

A. Finish concrete per Section 03 35 00 “Concrete Finishing” unless directed otherwise in this Section.

B. Round edges exposed to public view to a ½-inch radius.

C. Apply broom finish longitudinal to curb and gutter flowline.

D. Apply broom finish transverse to sidewalk centerline as follows:

1. Fine hair finish where grades are less than six (6) percent.

2. Rough hair finish where grades exceed six (6) percent.

E. Remove form marks or irregularities from finish surfaces.

3.7 TOLERANCES

A. Curb, Gutter, Curb and Gutter: APWA Plan 205, 209, 211, 213.

1. Line: Less than 1/2-inch variance in 10 feet and not more than 1 inch from true line at any location.

2. Grade: Not more than 1/4-inch variance in 10 feet. Flood curb and gutter with water after final set has been reached. Remove and replace any area where ponding is found.

3. Standing Water: None allowed.

B. Sidewalk: APWA Plan 231:

1. Cross slope one (1) percent minimum, two (2) percent maximum.

2. Standing Water: None allowed.

C. Driveway Approach: APWA Plan 215, 216, 221, 225, 229.

3.8 CURING

A. Curing of concrete shall be per Section 03 39 00 unless noted otherwise.

B. Curing compound: Apply at two (2) times manufacturer's recommended rate. Apply total coverage in two (2) directions after texturing.

C. Eliminate thermal shock of concrete by keeping cure temperature even throughout extent and depth of concrete slab.

3.9 PROTECTION AND REPAIRS

A. General: All expenses are at no additional cost to OWNER.

B. Protection: Section 03 30 10 "Concrete Placement":

1. Protect concrete work from deicing chemicals during the 28 days cure period.

2. Immediately after placement, protect concrete from graffiti or other types of mechanical injury.

C. Repair: Section 03 30 10 "Concrete Placement." Consider also guidelines published by the American Concrete Pavement Association (ACPA). Do not begin corrective work until ENGINEER agrees with repair option:

1. Correct all humps or depressions.

2. Standing Water: Remove and replace any area where ponding is found. If necessary, flood construction to determine ponding extent.

3. Restore surfaces damaged by saw cutting, grinding, or removal operations.

D. Protection of Marked Utilities: Take necessary precautions to prevent damage to marked utilities during concrete placement.

END OF SECTION

SECTION 32 16 14

CURB CUT ASSEMBLY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete flat work for public right-of-way accessibility.

1.2 REFERENCES

A. APWA (Utah) Standards:

1. Plan 235 Corner curb cut assembly.
2. Plan 236 Tangent curb cut assembly.
3. Plan 237 Islands and median.
4. Plan 238 Detectable warning surface.

1.3 SUBMITTALS

A. Field quality control ‘pass-fail’ checklist data.

B. Traffic control plan, Section 01 55 26 “Traffic Control.”

C. Concrete mix design, Section 03 30 00 “Cast in Place Concrete.”

D. Batch ticket, Section 03 30 10 “Concrete Placement.”

E. Detectable warning surface product data sheet.

F. Include supporting material for ADA compliance such as slope measurements and clearance dimensions.

1.4 QUALITY ASSURANCE

A. Table 1 – Field Quality Control Checklist.

1.5 ACCEPTANCE

A. Clear Space: Located within Crosswalk, Running Slope, Cross Slope.

B. Flow-line: No standing water, no trip hazard.

C. Detectable Warning Surface:

1. Color contrast, dome geometry, joints between units.
2. Cross Width, Running Length.

D. Curb Cut: Cross Width (appropriate to number of crosswalks served).

E. Turning Space: Running Slope, Cross Slope, dimensions.

F. Curb Ramp: Running Slope, Cross Slope, Cross Width.

G. Blended Transition: Running slope, Cross Slope, Cross Width.

H. A final inspection by the ENGINEER for ADA compliance.

1.6 DEFINITIONS

A. Approach: An Element in a pedestrian access route that connects a sidewalk to a Blended Transition or a Turning Space. It has a Running Slope of 8.33 percent (1:12) maximum, a Cross Slope of five (5) percent (1:20) maximum, and a Running Length to be determined by the ENGINEER.

B. Blended Transition: An Element in a pedestrian access route that connects a sidewalk or an Approach to a Crosswalk. It is 4 feet wide minimum and has a Running Slope of 5 percent (1:20) or less. Cross Slope may vary as follows:

1. Five (5) percent maximum at corners with no yield or stop controls.

2. Two (2) percent maximum at corners with yield or stop controls.

3. Street or highway grade at midblock.

C. Clear Space: An Element in a pedestrian access route that is located beyond the foot of a Curb Ramp, Turning Space, or Blended Transition and is within the width of the Crosswalk. Its dimensions are 4 feet minimum by 4 feet minimum with a Running Slope of 5 percent (1:20) maximum. Cross Slope may vary as follows:

1. Five (5) percent maximum at corners with no yield or stop controls.

2. Two (2) percent maximum at corners with yield or stop controls.

3. Street or highway grade at midblock.

D. Counter Slope: Running Slope of the roadway surface in a Crosswalk (including the pan of the gutter).

E. Cross Slope: Grade perpendicular to the direction of pedestrian travel usually expressed in percent.

F. Cross Width: Distance perpendicular to the direction of pedestrian travel usually expressed in linear measure.

G. Crosswalk (or Pedestrian Street Crossing):

1. Unmarked: That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the roadway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway. In the absence of a sidewalk on one side of the roadway, that part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line;

2. Marked: Any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by pavement marking lines on the surface, which might be supplemented by contrasting pavement texture, style, or color.

H. Curb Ramp: An Element in a pedestrian access route that is 4 feet wide minimum, has a Running Slope from 5 percent (1:20) to 8.33 percent (1:12) maximum and is not required to be more than 15 feet long. Curb ramps are perpendicular to or parallel with a curb. A perpendicular curb ramp abuts or cuts through the curb and its Turning Space is at the top of the ramp. A parallel curb ramp abuts the curb and its Turning Space abuts or cuts through the curb. Cross Slope may vary as follows:

1. Five (5) percent maximum at corners with no yield or stop controls.

2. Two (2) percent maximum at corners with yield or stop controls.

3. Street or highway grade at midblock.

I. Detectable Warning Surface: A surface feature of truncated dome material built into the walking surface to advise a pedestrian of an upcoming change from pedestrian to vehicular way.

J. Element: An architectural or mechanical component of a building, facility, space, site, or public right-of-way.

K. Grade Break: The line where two surface planes with different grades meet flush.

L. Running Length: Distance parallel to the direction of pedestrian travel usually expressed in linear measure.

M. Running Slope: Grade parallel to the direction of pedestrian travel usually expressed in percent.

N. Turning Space (or Landing): An element in a pedestrian access route that connects an Approach or a sidewalk to a Curb Ramp, a Blended Transition or a Clear Space. It is 4 feet minimum by 4 feet minimum. If constrained on 2 sides, it must be 5 feet minimum in the direction of the Curb Ramp or Blended Transition. It's Running Slope and Cross Slope is 2 percent (1:50) maximum. At midblock Crosswalks without stop control, the Cross Slope is permitted to equal the street or highway grade.

1.7 OWNER'S INSTRUCTIONS

A. Alterations: If the direction of water flow in an existing curb and gutter system is not apparent, proceed as follows:

1. Flood curb and gutter system to determine extent of replacement.

2. Flood curb and gutter system after installation to verify drainage.

B. Steep Slopes: Prior to placing concrete, allow ENGINEER time to check slopes and dimensions of construction forms.

C. Ensure that any alterations or deviations from the plan are approved by the ENGINEER before execution.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Class 4000, Section 03 30 00 “Cast in Place Concrete.”

2.2 DETECTABLE WARNING SURFACE

A. Concrete paver, ribbed composite panel, or tile.

B. Properties:

1. Homogenous color.

2. High shear strength domes.

3. Slip resistant, freeze thaw resistant, UV resistant.

PART 3 - EXECUTION

3.1 PREPARATION

A. Implement notification and traffic control plan requirements, Section 01 55 26 “Traffic Control.” Provide safe passage for pedestrians and vehicles.

B. Assist visually impaired and wheelchair users.

C. Provide continuous access to fire hydrants.

D. Keep passageways free of construction materials, trash, and debris.

E. Remove graffiti immediately.

F. Any existing utilities, service lines, or structural elements must be identified and marked prior to excavation.

3.2 INSTALLATION

A. Layout, APWA Plans 235, 236, 237, and 238.

B. Place concrete, Section 03 30 10 “Concrete Placement.”

C. Install Detectable Warning Surface full width of curb cut.

D. Care must be taken to ensure minimal disruption to the public during construction. Noise control measures may be required as per local ordinances.

3.3 FIELD QUALITY CONTROL

A. Use the 'pass-fail' checklist in Table 1 to verify that the curb cut assembly complies with layout requirements.

B.

Table 1 – Field Quality Control Checklist

Date: _____ Time: _____(am)(pm) Job No. _____

Job Title: _____

Indicate the intersection corner or adjacent street address member:

Intersection: _____, NE NW SE SW

Street Address Number:

Clear Space	Criterion	Pass	Fail
Located in the width of the crosswalk	Yes		
Running Slope	≤ 5%		
Proper Crosswalk striping	Yes or NA		
Gutter			
Slope (midblock)	Street Grade		
Slope (corner without yield or stop control)	≤ 5%		
Slope (corner with yield or stop control)	≤ 2%		
Slope (adjacent to a Turning Space)	≤ 2%		
Counter Slope (flow-line to pan lip)	≤ 5%		
Trip hazard at flow-line	No		
Trip hazard at roadway/pan joint	No		
Curb Ramp			
Running Slope	≤ 8.33%		
Blended Transition			
Running Slope	≤ 5%		
Turning Space			
Running Slope (midblock)	Street Grade		
Running Slope (corner)	≤ 2%		
Cross Slope	≤ 2%		
Approach			
Running Slope	≤ 8.33%		
Cross Slope	≤ 5%		
Detectable Warning Surface			
Spans curb cut in pedestrian access route	Yes		
Running Length	≥ 24"		
Color contrast	Yes		
Dome dimension and orientation	Yes		
Flare			
Slope (if in pedestrian access route)	≤ 10%		

3.4 CLEANING AND REPAIR

A. Remove all debris and concrete dust.

B. Clean surrounding handrails, sidewalks, driveways approaches, landscaping, and other objects in vicinity of work.

C. Repair surfaces damaged by saw cutting, grinding, or removal operations at no additional cost to OWNER.

END OF SECTION

SECTION 32 17 23

PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Words, striping, and other pavement markings.

2. One-way or two-way prismatic reflectors.

a. Reflectors must be made of high-intensity prismatic reflective sheeting, adhering to ASTM D4956 Type III, IV.

1.2 REFERENCES

A. AASHTO Standards:

1. M237 Epoxy Resin Adhesive for Bonding Traffic Markers to Hardened Concrete.

2. M247 Glass Beads Used in Traffic Paint.

3. M248 Ready-Mixed White and Yellow Traffic Paints.

4. M249 White and Yellow Reflective Thermoplastic Striping Material (Solid Form).

B. ASTM Standards:

1. D638 Tensile Properties of Plastics.

2. E303 Measuring Surface Frictional Properties Using the British Pendulum Tester.

3. E1710 Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retro reflectometer.

C. DOT Standards:

1. MUTCD Manual on Uniform Traffic Control Devices for Streets and Highways.

1.3 SUBMITTALS

A. Product data for primer to be used for tape applications.

B. Manufacturer's affidavit certifying paint products meet or exceed material requirements of this section.

C. Sample of prismatic reflector to be used along with manufacturer's statement of the reflector's minimum reflective area and specific intensity at the 0.2 degrees observation angle.

D. Manufacturer's recommendation for type of adhesive to be used.

E. Samples of each thermoplastic or preformed plastic pavement markings along with manufacturer's instructions of how the materials are to be applied.

1.4 QUALITY ASSURANCE

A. At the end of the correction period, pavement markings, when applied according to the recommendations of the manufacturer, show a neat, durable marking with no flow or distortion due to temperature if the pavement surface remained stable. The tape shows no appreciable fading, lifting or shrinkage, and no significant tearing, roll back or other sign of poor adhesion.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. Retroreflective: Majority of reflected light is directed back to the light source.

1.7 WEATHER

A. Apply pavement striping and markings only when pavement surface is dry and air temperature is above 40 deg F during daylight hours.

B. Do not apply pavement striping and markings when rain is anticipated within 12 hours.

C. Do not apply pavement striping and markings when wind speeds exceed 15 mph or relative humidity is above 80%.

PART 2 - PRODUCTS

2.1 GLASS BEADS

A. AASHTO M247

1. Glass beads should be round, clear, and 100% free of impurities, with a refractive index greater than or equal to 1.5 and a diameter between 0.3 to 0.85 mm.

2.2 FILM AND ADHESIVE

A. Film: A pliant polymer with retroreflective glass beads distributed throughout its cross-sectional area and bonded to its top surface. The film is selected and blended to conform to standard white or yellow highway colors and has a minimum thickness of 0.06 inches at pattern height.

1. Skid Resistance: 35 BPN minimum, ASTM E303.

2. Tensile Strength: ASTM D638. Using a Sample size six (6) x one (1) inch, a temperature between 70 and 80 deg F, and a test jaw speed of ten (10) to twelve (12) inches per minute, the film has an elongation of 75 percent maximum at break and a strength as follows.

   a. Type 1: 150 pounds minimum tensile strength per square inch of cross-section area.

   b. Type 2: 40 pounds minimum tensile strength per square inch of cross-section area.

3. Reflectivity: Meet film reflectivity in the following table.

Table 1 - Film Reflectivity

Application	Tensile Strength	Color	
		White	Yellow
Non-residential	Type 1	500	350
Residential	Type 2	300	250

NOTES:

1) Follow ASTM E1710 procedures using 30 meter test distance, an entrance angle of 88.76 degrees, and an observation angle of 1.05 degrees.
2) Reflectivity is measured in millicandelas per square foot per footcandle (med/sf/fc).

B. Adhesive:

1. Class 1: Without pre-coated adhesive for applications with surface preparation adhesive recommended by the manufacturer at temperatures of 40 deg F or above and moderate humidity.

2. Class 2: With pre-coated pressure sensitive adhesive with minimum adhesion value of 1.1 pounds per inch width, AASHTO M237.

2.3 PAINT

A. Alkyd type F (fast dry) ready-mix, AASHTO M248.

B. Thermoplastic, AASHTO M249.

2.4 PRISMATIC REFLECTORS

A. Unless indicated otherwise, provide single lens snowplow resistant reflectors of the color indicated:

1. With a cast iron housing and acrylic prismatic reflector.

2. With an overall size not less than nine (9) inches (228.6 mm) long, five (5) inches wide, and 1-3/4 inch thick with a seven sixteenths (7/16) inch maximum projection above its base.

3. With a minimum reflective area of one point six (1.6) square inches per face.

B. Reflectors must meet color requirements as per ASTM D4956 standards for reflective sheeting.

C. Reflector Specific Intensity: Meet intensity in the following table.

Table 2 - Intensity		
Color	Entrance Angle	
	0 Degrees	20 Degrees
White Yellow	3.0 1.8	1.2 0.72
NOTES: 1) Intensity measured at 0.2 degree observation angle.		

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Use equipment manufactured for pavement marking. Use workers experienced in operating such equipment.

B. Use equipment capable of applying a strip, or strips with a width tolerance of plus or minus 1/4 inch. Equip machine with an automatic skip control giving a ten (10) feet long marked segment and a thirty (30) feet long gap within a linear tolerance of six (6) inches over that cycle.

C. If applying glass beads, locate bead applicator directly behind and synchronized with marking applicator.

D. For thermoplastic paint materials, use equipment that is designed to agitate the paint to prevent scorching, discoloration, or excessive high temperatures.

3.2 PREPARATION

A. General: DO NOT begin pavement painting and marking operations without ENGINEER's knowledge of such activity. Provide written notice to the ENGINEER at least 48 hours before commencing work.

B. Repair of Receiving Surface: Method of payment to be determined by ENGINEER if any of the following repairs are required.

1. Raising low areas to grade, lowering high areas to grade, hole patching, inlays.

2. Crack sealing and crack repairing, Section 32 01 17 "Sealing Cracks in Bituminous Paving."

3. Pushing or shoving pavement repair.

a. Mill damaged area at least three (3) inches below required surface elevation.

b. Install and compact three (3) inches of bituminous concrete, Section 32 12 16. ENGINEER to determine Mix Designator.

C. Traffic Control:

1. Implement notification and traffic control plan requirements, Section 01 55 26 “Traffic Control.” Provide safe passage for pedestrians and vehicles. Do not proceed without certified flaggers if work requires.

2. Grind off confusing pavement markings and lane stripes.

D. Cleaning: Broom or flush the surface to remove dirt, loose stones, or other foreign material. For better adhesion results clean the surface using high velocity compressed air.

E. Mark Roadway: Mark roadway between control points established by ENGINEER. ENGINEER will establish points on tangent at least every 100 feet and at 25 feet long intervals on curves. Maintain the line within 1 inch of the established control points. ENGINEER may also designate other pavement striping locations such as stop bars, crosswalks, zebra striping, etc.

F. Markings: Markings that adhere to bituminous concrete or Portland cement concrete by either a pressure sensitive pre-coated adhesive or an epoxy cement shall mold to the pavement contours by traffic action at normal pavement temperatures and shall be ready for traffic immediately after application.

3.3 INSTALLATION - ALKYD RESIN PAINT STRIPING

A. Adjust pavement striping machine to apply paint at rate recommended by paint manufacturer. Provide two (2) applications over new pavement (pavement correction period has not expired).

B. Glass Bead Application Rate (Final Application): 5.9 to 6.1 pounds per gallon of paint.

C. Protect the markings until dry by placing approved guarding or warning device wherever necessary. Remove any markings not authorized or smeared or otherwise damaged, or correct as approved by ENGINEER.

D. Use a striping machine for applying paint and allow it to dry for at least 12 hours before allowing traffic.

3.4 INSTALLATION - THERMOPLASTIC PAINT STRIPING

A. Clean off dirt, glaze, and grease before pre-striping.

B. Pre-stripe the application area with a binder material that will form, when sprayed, a continuous film over pavement surface, and will dry rapidly and mechanically adhere to pavement surface. Install material in varying widths if indicated.

C. At a temperature recommended by the equipment manufacturer, extrude thermoplastic material from equipment that is proven to produce a line 1/8 inch to 3/16 inch thick, continuous, uniform in shape and has clean and sharp dimensions.

D. Do not use material that produces fumes that are toxic, obnoxious, or injurious to persons or property.

E. Apply so finished lines have well-defined edges free of waviness.

F. Glass Bead Application Rate: Six (6) pounds of glass beads to every 100 square feet of marking.

3.5 INSTALLATION - TAPE STRIPING

A. Apply pavement marking tape as indicated or directed. ENGINEER will establish control points.

B. Apply tape only on surfaces that are dry and free of oils, grease, dust and dirt, and primed at the rate of approximately one (1) quart per 60 feet with an approved primer material.

C. Ensure tape is applied with a uniform pressure using a roller or equivalent tool for complete adhesion.

D. Maintain the line on established control points. Apply intermittent pavement marking tape 24 inches long, spaced approximately 100 feet on tangents, and approximately 25 feet on curves unless otherwise directed. The ENGINEER will designate other pavement striping locations such as stop bars, crosswalks, zebra striping, etc.

E. Press down tape immediately after application until it adheres and conforms to pavement surface.

F. Completely remove all tape on sections where tape conflicts with revised traffic lanes before opening new lanes to traffic.

3.6 INSTALLATION PAVEMENT MARKING FILMS

A. Apply before traffic is allowed on freshly paved surface.

B. Unless indicated otherwise, provide Type 1, Class 2, polymer film markings in specified widths and shapes. Provide and layout words and marking symbol configurations per MUTCD requirements and as indicated.

C. When indicated, inlay markings in fresh bituminous concrete pavement with a compaction roller during the paving operation.

D. Apply all markings in accordance with manufacturer's recommendations.

3.7 INSTALLATION - PRISMATIC REFLECTORS

A. Install reflectors by cutting pavement and partially filling cut area with epoxy adhesive. Place reflector housing in the adhesive and apply pressure to properly seat. Allow epoxy to completely set before allowing traffic on markers. Cut pavement to a depth of 0.5 inches and use enough epoxy adhesive to fill the cut area to just below the surface.

B. Install markers so that housing top surface and edges are flush with pavement surface.

3.8 INSTALLATION - WORDS, SYMBOLS AND OTHER MARKINGS

A. Wet sandblast existing or temporary pavement markings that may be confusing. Removal of markings by high-pressure water may be used if approved by ENGINEER.

B. Apply word markings, letters, numerals and symbols with indicated stencils and templates. In the absence of such information all stencils and templates shall be identical to those currently used by OWNER.

3.9 REPAIR

A. Before the end of the correction period, renew stripes and markings if original visual effectiveness is reduced by 50 percent. Repairs must be conducted using the same material as the initial installation and will be inspected and approved by the ENGINEER.

END OF SECTION

SECTION 32 17 26

TACTILE WARNING SURFACING

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. The work of this Section includes installation of tactile warning material at sidewalks. These curb cuts as shown in Construction Documents.

B. Related Sections:

1. Section 07 90 00 - Caulking
2. Section 03 30 00 “Cast in Place Concrete”: Concrete for sidewalks and platforms.
3. Section 32 13 13 “Concrete Paving”

1.2 REFERENCES

A. Reference Standards:

1. 49CFR37 – Transportation Services for Individuals with Disabilities (ADA) current edition.
2. AASHTOLRFD – Bridge Design Specifications 2017, with Errata (2018).
3. ADA Standards – Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
4. ASTMA666 – Standard Specification for Annealed or Cold – Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
5. ASTMB117 – Standard Practice for Operating Salt Spray (Fog) Apparatus 2019.
6. ASTMC501 – Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser 1984 (Reapproved 2015).
7. ASTMC903 – Standard Practice for Preparing Refractory Specimens by Cold Gunning 2015, with Editorial Revision (2016).
8. ASTMD2047 – Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine 2017.
9. ASTMD543 – Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents 2020.
10. ASTMD570 – Standard Test Method for Water Absorption of Plastics 1998 (Reapproved 2018).

11. ASTMD638 – Standard Test Method for Tensile Properties of Plastics 2014.

12. ASTMD695 – Standard Test Method for Compressive Properties of Rigid Plastics 2015.

13. ASTMD790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials 2017.

14. ASTME84 – Standard Test Method for Surface Burning Characteristics of Building Materials 2020.

15. ASTMG155 – Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials 2013.

16. ATBCBPROWAG – Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-Of-Way 2011.

17. SAEAMS-STD-595 – Colors Used in Government Procurement 2017 a.

1.3 SUBMITTALS

A. See Section 01 30 00 “Administrative Requirements”, for submittal procedures.

B. Shop Drawings: Submit plan and detail drawings. Indicate:

1. Locations on project site. Demonstrate compliance with referenced accessibility standards.

2. Sizes and layout.

3. Pattern spacing and orientation.

4. Attachment and fastener details, if applicable.

C. Manufacturer's Qualification Statement.

D. Warranty: Submit manufacturer warranty; complete forms in OWNER’s name and register with manufacturer.

1.4 QUALITY CONTROL

A. Quality control shall be made in accordance with the requirements of the General Provisions, except as modified herein.

B. Engage an experienced installer (either as a direct employee or as a subcontractor) who has completed warning strip installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. Source or brands of mortar, grout or admixture materials shall not be changed during the course of the Work. Obtain each color and type of joint and setting materials from a single source with resources to provide products and materials of consistent quality in appearance and physical properties without delaying the work.

D. When installation location is near site boundary or property line, verify required location using property survey.

E. Verify that work area is ready to receive work:

1. If existing conditions are not as required to properly complete the work of this section, notify ENGINEER.

2. Do not proceed with installation until deficiencies in existing conditions have been corrected.

F. Verify that dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work on site.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 WARRANTY

A. See Section 01 78 00 “Closeout Submittals”, for additional warranty requirements.

B. Plastic Tiles: Provide manufacturer's standard five-year warranty against manufacturing defects, breakage, or deformation.

1.7 DELIVERY, STORAGE AND HANDLING

A. Tactile warning materials shall be protected during storage and construction against wetting by rain, snow, or ground water and against spoilage or intermixture with earth or other types of materials. Wrap materials in plastic or use other packaging materials that will prevent rust marks from steel strapping.

B. Grout and mortar materials shall be protected from deterioration by moisture and temperature. CONTRACTOR shall store in a dry location or in waterproof containers. Containers shall be kept tightly closed and away from open flames. Liquid components shall be protected from freezing. Comply with manufacturer's recommendations for storage if more stringent, and with minimum and maximum storage temperature requirements.

C. Protect stored materials from discoloration due to differential light exposure.

1.8 PROJECT CONDITIONS

A. Pre-Installation Conference.

1. Before beginning tactile warning strip and associated work, the Subcontractor, with concrete foreman, shall meet at the Project site with the CONTRACTOR’s Superintendent, the installer of each component of the associated work, the representatives of the warning strip manufacturer, installers of other work requiring coordination with warning strip work and the ENGINEER for a pre-installation conference.

2. The material selections and procedures to be followed in performing the work shall be reviewed to verify compliance with the requirements specified.

3. Expansion joint materials compatibility shall be verified to meet requirements herein.

4. If either the concrete foreman or CONTRACTOR's Superintendent are replaced before completion of work of this Section, the conference shall be repeated.

B. Frozen Work.

1. Frozen materials or materials mixed or coated with ice or frost shall not be used.

2. Tactile warning strip work damaged by frost or freezing shall be removed and replaced at no cost to UTA.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ADA Solutions, Engineered Plastics – Armor Tile, or approved equals

2.2 MATERIALS

A. Plastic Tactile and Detectable Warning Tiles: ADA Standards compliant, glass fiber and carbon fiber reinforced, exterior grade, matte finish polyester sheet with truncated dome pattern, solid color throughout, internal reinforcing of sheet and of truncated domes, integral radius cut lines on back face of tile; with factory-applied removable protective sheeting.

1. Material Properties:

a. Water Absorption: 0.20 percent, maximum, when tested in accordance with ASTM D570.

b. Slip Resistance: 0.50 minimum dry static coefficient of friction, when tested in accordance with ASTM D2047.

c. Compressive Strength: 25,000 pounds per square inch (172 MPa), minimum, when tested in accordance with ASTM D695.

d. Tensile Strength: 10,000 pounds per square inch (69 MPa), minimum, when tested in accordance with ASTM D638.

e. Flexural Strength: 25,000 pounds per square inch (172 MPa) minimum, when tested in accordance with ASTM D790.

f. Chemical Stain Resistance: No reaction to 1 percent hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, or antifreeze, when tested in accordance with ASTM D543.

g. Abrasion Resistance: 300, minimum, when tested in accordance with ASTM C501.

h. Flame Spread Index: 25, maximum, when tested in accordance with ASTM E84.

i. Accelerated Weathering: Delta-E of less than 5.0 at 2,000 hours exposure, when tested in accordance with ASTM G155.

j. Adhesion: No delamination of tile prior to board failure in a temperature range of 20 to 180 degrees F (minus 7 to 82 degrees C), when tested in accordance with ASTM C903.

k. Loading: No damage when tested according to AASHTO LRFD test method HS20.

l. Salt and Spray Performance: No deterioration or other defect after 200 hours of exposure, when tested in accordance with ASTM B117.

2. Installation Method: Cast in place.

3. Shape: Rectangular.

4. Dimensions: 24 inches by 48 inches (610 mm by 1220 mm).

5. Pattern: In-line pattern of truncated domes complying with ADA Standards.

6. Edge: Square.

7. Joint: Butt.

8. Color: SAE AMS-STD-595, Table IV, Federal Yellow No. 33538.

9. Products:

a. ADA Solutions, LLC; Transit Use - In-Line Dome Surface Applied System: www.adatile.com/#sle.

b. Substitutions: See Section 01 60 00 “Product Requirements.”

2.3 SUPPLEMENTAL MATERIALS

A. Other materials used in the installation shall be as approved by tile manufacturer.

B. Fasteners: ASTM A666, Type 304 stainless steel.

1. Type: Countersunk, color matched composite sleeve anchors

2. Size: 1/4 inch (6.35 mm) diameter and 1-1/2 inches (38 mm) long.

C. Sealant: Elastomeric sealant of color to match adjacent surfaces; approved by surfacing tile manufacturer.

PART 3 – EXECUTION

3.1 TRAINED AND CERTIFIED BY THE MANUFACTURER

A. Acceptable installers shall be trained and certified by the manufacturer.

3.2 EXAMINATION

A. A. When installation location is near site boundary or property line, verify required location using property survey.

B. Verify that work area is ready to receive work:

1. If existing conditions are not as required to properly complete the work of this section, notify ENGINEER.

2. Do not proceed with installation until deficiencies in existing conditions have been corrected.

C. Verify that dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work onsite.

3.3 INSTALLATION

A. Tactile warning strips containing chips, cracks and other defects that may be detrimental to the safety or aesthetic qualities of the finished job or are out of dimensional requirements shall not be used.

1. Tiles shall not vary from sizes stated in subparagraphs of Paragraph 2.2 by more than plus or minus 1/8 inch.

B. Tactile warning strips shall be cut with motor-driven saw equipment, only, designed to cut tactile warning strips with clean, sharp, unchipped edges. Warning strips shall be cut as required to provide the pattern shown and to fit adjoining work neatly. Full warning strips shall be used without cutting wherever possible. Where cutting is required, the largest tactile warning strip possible shall be used with no cutting through raised domes.

C. Before initial set of concrete bed occurs, tactile warning strips shall be placed. Tactile warning strips shall be tamped and beat in for a complete contact with setting bed. Each tactile warning strip shall be set and leveled in a single operation.

1. Tactile warning strips shall be set in pattern shown on Contract Drawings with varying joint widths as necessary to align the centerlines of joints with a 1'-0" module and with the centerlines of concrete scoring joints, concrete construction joints, concrete control joints, and concrete expansion joints. Tactile warning strips shall be placed firmly on the concrete bed in a manner assuring a minimum of 95% contact. Surface plane of the tactile warning strips shall not vary more than 1/8 inch plus or minus from the designed grade at any point.

D. Install expansion joints where warning strips abut restraining surfaces, such as perimeter walls, curbs, columns, wall corners, and directly over cold joints (pour joints) and control joints in structural surfaces. Conform to Contract Drawings, requirements of this Section, and the requirements of Section 07900. Protect and preserve the expansion joint sealant backer assembly. Take reasonable and extraordinary precautions required to protect, prevent damage, preserve, and maintain indicated alignment and grade.

3.4 ADJUSTING AND CLEANING

A. Tactile warning strips which are loose, chipped, broken, stained or otherwise damaged, and warning strips which do not match adjoining warning strips, shall be removed and replaced. Warning strips which have exposed surfaces above or below adjacent warning strips shall also be removed and replaced. Replacement of tactile shall include the necessary removal and replacement of concrete surface necessary to match the remaining tile.

B. New warning strips to match adjoining warning strips shall be furnished and installed in fresh mortar or grout and shall be pointed to eliminate evidence of replacement.

C. Remove excess cement paste from exposed tactile warning strip surfaces, wash and scrub clean.

D. Remove protective plastic sheeting within 24 hours of installation.

E. Provide final protection and maintain conditions in a manner acceptable to installer that ensures that tactile warning strip work is without damage or deterioration at the time of Substantial Completion.

3.5 PROTECTION

A. Protect installed units from traffic, subsequent construction operations or other imposed Loads until concrete is fully cured.

B. Touch-up, repair or replace damaged products prior to Date of Substantial Completion.

END OF SECTION

SECTION 32 31 13

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain link fabric, posts, braces, anchorage, gates, miscellaneous hardware and appurtenances.

1.2 REFERENCES

A. ASTM Standards:

1. A53 Pipe, Steel, Black and Hot- Dipped, Zinc-Coated, Welded and Seamless.
2. A121 Zinc Coated (Galvanized) Steel Barbed Wire.
3. A392 Zinc Coated Steel Chain-Link Fence Fabric.
4. A491 Aluminum Coated Steel Chain-Link Fence Fabric.
5. A585 Aluminum Coated Steel Barbed Wire.
6. A641 Zinc Coated (Galvanized) Carbon Steel Wire.
7. F567 Installation of Chain-Link Fence.
8. F573 Residential Zinc Coated Steel Chain-Link Fence Fabric.
9. F626 Fence Fittings.
10. F654 Residential Chain-Link Fence Gates.
11. F668 Poly(Vinyl Chloride) (PVC) Coated Steel Chain-Link Fence Fabric.
12. F1043 Strength and Protective Coatings on Steel Industrial Chain Link Fence and Framework.

B. CLFMI Standards:

1. Manual for Chain Link Fence Installation.

1.3 SUBMITTALS

A. Drawings: Indicate plan layout, grid, size and spacing of components, accessories, fittings, anchorage, and post section.

B. Data: Submit manufacturer's installation instructions and procedures, including details of fence and gate installation.

C. Submit sample of fence fabric and typical accessories.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 GENERAL

A. Galvanizing: Class 3, ASTM A121.

B. Aluminizing: Class 2, ASTM A585.

C. Polyvinyl Chloride (PVC): For PVC coated materials, paint all posts, fittings, hardware and accessories to match PVC color.

D. Steel Post: Schedule 40, ASTM A53.

E. Concrete: Class 3000 minimum cast-in-place, Section 03 30 00.

2.2 CHAIN LINK FABRIC

A. Steel wire fabric, 11 gage for all fences less than 60 inches in height and nine (9) gage for fences over 60 inches coated as follows:

1. Zinc coating, ASTM A392.

2. Aluminum coating, ASTM A491.

3. Polyvinyl chloride coating, ASTM F668. The fabric shall be hot dipped galvanized steel wire complying with ASTM A392 and coated with a continuous PVC bonding process (minimum 15 mil thickness). Color of PVC coating as indicated and applied free of voids, cracks, tears and to have a smooth and lustrous surface.

B. For residential fabric, provide zinc coated fabric, ASTM F573.

C. Unless indicated otherwise use chain link fabric that has approximately two (2) inches square mesh and coated after fabrication.

D. Knuckle finish top edge and twist and barb bottom edge on fabric less than 60 inches wide. For wider fabric, twist and barb finish on both edges. Provide fabric with barbing done by cutting the wire on bias.

E. If indicated, insert slats in fabric.

2.3 BARBED WIRE

A. Two strand, 12-1/2 gage wire with 14 gage, four (4) point round barbs spaced approximately five (5) inches on center.

2.4 TENSION WIRES AND FABRIC TIES

A. Tension Wires: Seven (7) gage galvanized coil spring steel wire, ASTM A641.

B. Fabric Fasteners: None (9) gage galvanized or six (6) gage aluminum wire, or approved non-corrosive metal bands, for ties to fasten fabric to posts, rails, and gate frames. Fasten fabric to bottom tension wire spaced 24 inches on center.

2.5 TRUSS OR TENSION BARS

A. Galvanized steel rod 3/8 inch diameter for truss or tension bars used in trussing gate frames and line posts adjacent in end, corner, slope, or gate posts. When used in trussing line posts, provide adjustment by means of galvanized turnbuckles or other suitable tightening devices.

B. Tension Bars:

1. Galvanized high carbon steel bars not smaller than 3/16 inch x 3/4 inch for tensions bars to fasten fabric to end and corner posts and gate frames. Provide 1 tension bar for each end post and two (2) for each corner and pull post per section of fabric.

2. Use tension bar bands made from heavy pressed galvanized steel spaced on 15 inch centers to secure tension bars to posts.

2.6 POSTS, CAPS, RAILS, COUPLINGS

A. Posts, Frames, Stiffeners, Rails: ASTM F1043.

Table 1 – Posts, Frames, Stiffeners, Rails

Proposed Use	Nominal Type and Size
End, corner, slope and gate posts for single gates 6 feet or less in width and double gate 12 feet or less in width for 1. Fence less than 72 in. high 2. Fence 72 inches or higher	2" pipe 2-1/2" pipe
Gate posts for single swing gates over 6 feet, but not over 13 feet in width and double swing gates over 12 feet, but not over 24 feet in width or for all slide gates with leaves larger than 6 feet	3-1/2" pipe
Gate posts for single swing gates over 13 feet, but not over 18 feet in width and double swing gates over 24 feet, but not over 36 feet in width	6" pipe

Gate posts for single swing gates over 18 feet in width and double swing gates over 36 feet in width	8" pipe
Frame for gates	1-1/2" pipe
Stiffeners for gates	1-1/4" pipe
Line posts for fence 72 in. or higher	2" pipe
Line posts for fences less than 72 in. high	1-1/2" pipe, or 1-1/8" x 1-5/8" H
Top rail	1-1/4" pipe, or 1-1/2" x 1-1/4" H
Bottom rail	6-gage, coiled spring steel tension wire

B. Posts: Galvanized steel, at indicated length.

C. Caps: Pressed galvanized steel or malleable iron designed to fit securely over post ends forming a weather tight closure. Where top rail is used, provide cap to permit passage of top rail. "H" section posts do not require caps.

D. Top, Intermediate and Bottom Rails: Galvanized steel, in required lengths. Provide joint couplings to connect rails securely. Provide means for attaching top rail securely to each end, corner, line, slope and gate posts.

E. Joint Coupling: Galvanized steel, six (6) inches long minimum for each joint. 1 coupling in five (5) shall have expansion spring. Couplings shall be outside sleeve type with bore of sleeve true to maintain adjacent lengths of rail in alignment.

2.7 FITTINGS AND HARDWARE

A. Galvanize fittings and hardware.

B. Rivets: Galvanized steel.

2.8 SUPPORT OR EXTENSION ARM

A. Use support or extension arms for barbed wire that are of a type that can be attached to tops of the posts and carry number of wires indicated.

B. Use only support arms that are capable of supporting a 250 pound vertical load at the end of the arm without causing permanent deflection.

C. Single support arms are to be integral with a top post weather cap and have a hole for passage of the top rail when required.

2.9 GATES

A. Residential Gates: ASTM F654.

B. Provide additional horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware and accessories.

C. Assemble gate frames and attach hardware by welding or by using fittings and rivets to make rigid connections. Use same fabric as for fence. Install fabric with stretcher bars to gate frame at not more than 15 inch on center.

D. Provide diagonal cross-bracing consisting of 3/8 inch diameter adjustable length truss rods on gates where necessary to prevent frame from sagging or twisting.

2.10 GATE HARDWARE

A. Hinges: Pressed steel or malleable iron to suit gate size, non-lift-off type, offset to permit 180 degree gate opening. Provide minimum of one pair of hinges for each leaf.

B. Latch: Forked steel type or plunger-bar steel type to permit operation from either side of gate. Provide locking device and padlock eye as integral part of latch.

C. Keeper: Provide keeper for all vehicle gates which automatically engages the gate leaf and holds it in the open position until manually released.

D. Gate Stops: Mushroom type or flush plate with anchors set in concrete to engage the center drop rod or plunger bar.

E. Sliding Gates: Manufacturer's standard heavy-duty track, ball-bearing hanger sheaves, overhead framing and supports, guides, stays, bracing, steel wheel or rubber wheel, and accessories as required.

PART 3 - EXECUTION

3.1 PREPARATION

A. Locate and preserve utilities.

B. Excavation, Section 31 23 16 “Excavation.”

C. Review to ASTM F567 and CLFMI products manual for chain link fence installation.

D. Protect roots and branches of trees and plants to remain.

E. Limit amount of clearing and grading along fence line to permit proper installation.

3.2 LAYOUT OF WORK

A. Accurately locate and stake locations and points necessary for installation of fence and gates.

B. General arrangements and location of fence and gates are indicated. Install except for minor changes required by unforeseen conflicts with work of other trades.

3.3 INSTALLATION OF POSTS

A. Space line posts as follows:

1. Tangent sections to 500 feet radius: 10 feet maximum.

2. 200 feet radius to under 500 feet radius: Eight (8) feet maximum.

3. 100 feet radius to under 200 feet radius: Six (6) feet maximum.

4. Under 100 feet radius: Five (5) feet maximum.

B. Provide pull posts at 500 feet maximum intervals. Changes in line of 30 degrees or more are considered corners.

C. Set all posts to true line and grade in concrete bases or in approved pipe sleeves or sockets. Check for vertical and horizontal alignment.

D. Construct concrete bases for posts at least 10 inches in diameter. Place a minimum of six (6) inches concrete below each post. Depth of post in concrete as follows:

1. Line Posts: 18 inches.

2. End, Pull, Corner and Gate Posts Less Than six (6) inches Diameter: 24 inches.

3. Gate Posts: 30 inches.

E. Where posts are required to be set in concrete walls or masonry, set sockets for posts to a depth of at least 18 inches. Use sockets that consist of lengths of 0.048 inch galvanized metal pipe sleeves, with an inside diameter sufficient to allow the posts to fit loosely. Coat inside of socket and outside of posts with bituminous paint. Caulk posts securely in place with lead wool.

3.4 INSTALLATION OF BRACE ASSEMBLIES

A. Attached brace rail from end, pull, corner or gate posts to first ensuing line post. Install braces so posts are plumb when diagonal truss rod is under proper tension.

3.5 INSTALLATION OF RAILS

A. Install rails level and plumb with grade between posts and attached to posts before stretching fabric. Top rails shall form continuous brace from end-to-end of each run of fence.

3.6 INSTALLATION OF FENCE FABRIC

A. Place fence fabric on security side of posts unless otherwise specified. Place fabric approximately 1 inch above the ground. Maintain a straight grade between posts by excavating ground high points. Filling depressions with soil.

B. Stretch fabric taut and securely fasten to posts. Fasten to end, gate, corner, and pull posts. Secure stretcher bars with metal bands spaced at 15 inch intervals. Cut the fabric and fasten each span independently at all pull and corner posts. Fasten to line posts with tie wire, metal bands, or other at 15 inches intervals. Attach the top edge of fabric to the top rail or tension cable at approximately 24 inches intervals. Attach bottom tension wire to fabric with tie wires at 24 inches intervals and secure to end of pull posts with brace bands.

C. Draw barbed wire to assure minimum sag at high temperature and no breakage at low temperature. Connect wires and arms by means of 0.142 gauge galvanized wire stays.

3.7 INSTALLATION OF GATES

A. Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation.

3.8 REPAIR DAMAGED COATING

A. Grind smooth and wire brush all welds made after galvanizing to remove loose or burned zinc coating, after which neatly coat the areas with 50-50 solder or as otherwise directed by ENGINEER. Make repairs to abraded or otherwise damaged zinc coating in a similar manner. Replace PVC coating.

END OF SECTION

SECTION 32 31 16

WELDED WIRE FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wire fences and gates for roadway right-of-way lines.

1.2 REFERENCES

A. Related Sections:

1. Concrete: Class 3000 minimum cast-in-place, Section 03 30 00 “Cast in Place Concrete.”

B. AASHTO Standards:

1. M133 Preservatives and Pressure Treatment Process for Timber.

C. ASTM Standards:

1. A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. A116 Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric.
3. A121 Zinc-Coated (Galvanized) Steel Barbed Wire.
4. A585 Aluminum-Coated Steel Barbed Wire.
5. A641 Zinc-Coated (Galvanized) Carbon Steel Wire.
6. A702 Steel Fence Posts and Assemblies, Hot-Wrought.

D. NFPA Standards:

1. 79 National Electric Code.

1.3 SUBMITTALS

A. Drawings: Indicate plan layout, grid, spacing of components, accessories, fittings, and anchorage.

B. Data: Submit manufacturer’s installation instructions and procedures, including details of fence and gate installation.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 GENERAL

A. Galvanizing, ASTM A121: Class 3.

B. Aluminizing, ASTM A585: Class 2.

C. Polyvinyl Chloride (PVC): For PVC coated materials, paint all posts, fittings, hardware and accessories as indicated to match PVC color.

D. Steel Pipe, ASTM A53: Schedule 40.

2.2 WIRE MESH FABRIC

A. Class II, ASTM A116, nominal 0.099 inch Farm Grade with a six (6) inch vertical wire spacing with wire mesh and spiral stays having a Class 1 zinc coating.

B. For PVC coated fabric, the fabric shall be hot-dipped galvanized steel wire complying with ASTM A392 and coated with a continuous PVC bonding process (minimum 15 mil thickness) in accordance with ASTM F668. Color of PVC coating as indicated. Applied free of voids, cracks, tears and to have a smooth and lustrous surface.

2.3 BARBED WIRE

A. Two strand, 12-1/2 gage wire with 14 gage, four (4) point round barbs spaced approximately five (5) inches on center.

2.4 UNTREATED WOOD POSTS FOR LINES, GATES, ENDS AND CORNERS

A. Line posts: 10 inches minimum circumference Juniper or acceptable alternate.

B. Gate, Brace, and Corner Posts: 12 inches minimum circumference minimum Juniper or acceptable alternate.

C. Use only sound straight posts that are free from decay or defects.

2.5 TREATED WOOD POSTS AND WOOD BRACE RAILS

A. Douglas Fir, Hemlock, or Pine as follows:

1. Line Posts: 10 inches minimum circumference.

2. Gate, Brace, and Corner Posts: 12 inches minimum circumference.

3. Rectangular Posts: 12 square inches minimum cross-section area rough sawn or finished.

B. Pressure treat wood members before fabrication, AASHTO M133.

C. Before painting, treat lumber per AASHTO M133 requirements using pentachlorophenol solution.

D. Sawing or field drilling of holes is allowable if all exposed untreated surfaces of members are field treated with two (2) coats of the same material originally treated.

2.6 METAL POSTS AND BRACES

A. Steel posts, ASTM A702.

B. The anchor plate may be omitted provided posts are set in a concrete footing with a minimum cross-sectional dimension of six (6) inches and a depth equal to full penetration of the post plus six (6) inches.

C. Galvanized posts may be used in the place of the painted posts. Use posts galvanized by the hot-dipped process, Section 05 05 13.

2.7 TUBULAR STEEL FRAME GATE WITH WIRE FABRIC

A. Gate frames manufactured with steel pipe 1 inch nominal diameter steel pipe minimum.

B. Place steel pipe braces vertically in each drive gate to provide uniform size panels. Provide one vertical support for 10 and 12 feet wide gates and two (2) vertical supports for 14 to 16 feet wide gates.

C. Gate dimensions are the minimum clear openings between gate posts. Provide a gate with fittings to fill the opening.

D. Provide galvanized woven wire fabric of the same type and quality as indicated for the fence, and space the horizontal wires corresponding to that of the fence. Provide an adjustable steel truss rod of 3/8 inch minimum diameter to prevent sagging on gates 10 feet or more in length.

E. Galvanize steel fitting and hardware, APWA Section 05 05 10.

F. For 10 feet wide and wider gates use pintles not less than 5/8 inch diameter.

G. For single gate fasteners furnish an 18 inches length of galvanized chain secured to the gate at one end and fitted with a snap fastener on the loose end. For all double drive gates use a center latch in lieu of a chain fastener with a pin that fits in a socket embedded in concrete.

H. For sliding gates use a frame made from 1-1/4 inch steel tubing with fence fabric equal to the adjoining fence. Support the opening end on a set of six (6) inches minimum diameter wheels. Provide a 1-1/2 inch minimum schedule 40 pipe to support the other end with a steel wheel that rides on the support pipe. On gates wide than 12 feet use two (2) support pipes. If a pre-manufactured gate is to be used, submit details for review.

2.8 STAPLES

A. Galvanized steel No. 9 wire 1-1/2 inches long minimum with an ASTM A641 Class I coating.

PART 3 - EXECUTION

3.1 PREPARATION

A. Locate and preserve utilities, Section 31 23 16 “Excavation.”

B. Excavation, Section 31 23 16 “Excavation.”

C. Limit amount of clearing and grading along fence line to permit proper installation.

3.2 INSTALLATION

A. Install permanent end braced posts for existing cross fences which are intersected by the new fence alignment. Place all end braced posts in position in existing cross fence to serve as line posts for connection to the new fence. Space fence posts at intervals and depth required. Install all posts in a vertical position.

B. After wood post has been set, cut off top to height indicated at an angle of approximately 30 degrees from horizontal.

C. Brace corner and end post in two directions.

D. Set metal corner, end, gate, and brace posts in concrete footings that are 12 inches larger in diameter than the post and at least 24 inches deep. Crown top to shed water. Install no materials on posts or place strain on guys until seven (7) days after placing concrete.

E. Draw wire mesh fabric tight to remove all sag.

F. Excavate high points along the ground surface that interferes with placing of wire mesh. Provide a minimum clearance of 1 inch and four (4) inches maximum.

G. Draw barbed wire to assure minimum sag at high temperatures and no breakage at low temperatures. Connect the lateral wires between posts by means of 0.142 inch diameter galvanized wire stays of length indicated.

H. Fasten top and bottom wires and every alternate lateral wire in mesh fabric and each strand of barbed wire to each post by means of the staple or clamp. Connect wood braces to adjacent posts with 3/8 inch x 4 inch galvanized steel dowels and tension brace wires until installation is rigid.

I. Fasten metal braces to metal post by the use of a securely bolted assembly or butt welding.

J. Provide double diagonal wire bracing at each timber bracing consisting of two 0.192 inch diameter galvanized wires securely fastened to wood posts.

K. Construct gates to operate freely without sag. Provide fittings and locks.

L. At each location where an electric transmission distribution or secondary line crosses any fence with wood posts, install an electric ground conforming to NFPA 70 requirements.

END OF SECTION

SECTION 32 31 19

DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative steel fences, custom fabricated, with woven wire infill.
2. Swing gates - G-1, G-2, G-7.
3. Horizontal-slide gates - G-3.

B. Work by Owner: Access control devices such as card readers, keypads, and cabling.

C. Related Requirements:

1. Section 01 60 01 "Buy America Requirements" for special product requirements.
2. Section 03 30 00 "Cast-in-Place Concrete" for concrete post concrete fill.
3. Section 32 31 13 "Chain Link Fences and Gates."

1.2 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.
2. Shop Drawings: Submit for review and approval shop drawings for the fabrication and installation of all items. Show plans, elevations, sections, and details for each type of fence and gate. Show installation details for each type of fence and gate for each type of condition. Show concrete support, posts, rails, fencing design, hardware. Indicate heights of fencing and all field verified dimensions, elevations, and conditions. Indicate if it will be necessary to step height of fencing due to grade elevation changes, either accumulative or at specific points. Submit a survey, site plan showing the location of each type of fence and gate.
3. Indicate on shop drawings plans, elevations, and details for gates. Indicate single and double gates. Indicate size (width and height), direction of operation, construction, support posts at each side, reinforcing and all hardware including hinges, latch, lock, pulls or knobs, closer and other items.

4. Samples: Submit actual finish and selected color samples for ornamental iron fencing materials, including posts, framing, pickets, and hardware. Provide samples of actual materials are requested by Authority.

5. Product Data: Submit technical data for all materials. For ornamental fencing and gates, indicate post and rail shapes, sizes, and thicknesses of metal; size, design, and spacing of pickets; hardware specs for end caps and other accessories. Indicate specifications for galvanizing, coating types, and finishes.

6. Supplementary Product Literature: Furnish manufacturer's literature describing the general properties of each product to be used, including all hardware for gates.

7. Structural Calculations: Fence supplier to provide structural calculations indicating that the sizes of wire, wire mesh and framing members are sufficient at the spacings and spans shown to sustain the design loads for the fence system.

8. Galvanizing Certification: For all components; provide certification for hot-dipped galvanizing of all materials after fabrication.

9. Provide information required by Quality Assurance section of this specification section including qualifications, certifications, experience and references for the fabricator, finisher, installer and welder for the ornamental iron fencing and gates.

10. Provide a copy of the warranty for the fencing system for the OWNER's review and approval.

11. Provide product data for materials and installation instructions for grounding system for fence installation(s), if applicable.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Fabricator Qualifications: Engage a firm with at least five years' experience in fabricating wire mesh panels similar to those indicated for this Project and that have a record of successful in-service performance for similar installations.

C. Galvanizer's Qualifications: Engage galvanizing firms with at least five years' experience in hot dip galvanizing materials similar to the products indicated for this Project.

D. Finisher's Qualifications: A firm with at least five years' experience in providing the specified thermosetting epoxy powder coating and the spray application of polyester powder finish coating.

E. Installer Qualifications: Arrange for installation of ornamental iron fence and gates specified in this section by same firm that fabricated them or approved by them.

F. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code - Steel" and AWS D1.3 "Structural Welding Code - Sheet Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone re-certification.

G. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Coordinate with OWNER for access control devices installed at gates and provided as part of a security system.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.2 DECORATIVE STEEL FENCES, CUSTOM FABRICATED

A. Decorative Steel Fences: Fences made from steel tubing and shapes.

B. Posts: Square steel tubing.

1. Vertical Fence Framing: 2 by 2 inches with 1/8-inchwall thickness.

2. Fence Posts: 4 by 4 inches with 3/16-inch wall thickness.

3. Swing Gate Posts: 6 by 6 inches with 3/16-inch wall thickness.

C. Post Caps: Formed from steel sheet.

D. Rails:

1. Steel Tube Rails: Square steel tubing 2 by 2 inches with 1/8-inch wall thickness.

E. Infill:

1. Woven-Wire Mesh: 2x2 W1.4xW1.4 welded-wire mesh plain, fabricated from plain, as-drawn steel wire into flat sheets complying with ASTM A1064/A1064M. Crimp into 1-by-1/2-by-1/8-inch steel channel frames. Orient wire mesh with wires horizontal and vertical.

F. Fabrication: Assemble fences into sections by welding.

G. Finish exposed welds to comply with NOMMA Guideline 1, Finish #3 - partially dressed weld with splatter removed.

H. Finish for Steel Items: Powder coating or High-performance polyurethane coating.

2.3 SWING GATES

A. Gate Configuration: As indicated on Drawings.

B. Gate Frame Height: As indicated on Drawings.

C. Gate Opening Width: As indicated on Drawings.

D. Steel Frames and Bracing: Fabricate members from square steel tubing 2 by 2 inches with 1/8-inch wall thickness.

E. Frame Corner Construction: Welded and 5/16-inch- diameter, adjustable truss rods for panels 5 feet wide or wider.

F. Additional Rails: Provide as indicated, complying with requirements for fence rails.

G. Infill: Comply with requirements for adjacent fence.

H. Hardware: Slide bolts, cane bolts, hinges, and keepers for each gate leaf. Fabricate latches with integral eye openings for padlocking.

I. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.

2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.

J. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch-diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in closed position.

K. Finish exposed welds to comply with NOMMA Guideline 1, Finish #3 - partially dressed weld with splatter removed.

L. Steel Finish: Same as fence framing.

2.4 HORIZONTAL-SLIDE GATES

A. Gate Configuration: As indicated.

1. Type: Cantilever slide, with external roller assemblies.

B. Gate Frame Height: As indicated on Drawings.

C. Gate Opening Width: As indicated on Drawings.

D. Steel Frames and Bracing: Fabricate members from tubing.

1. Frame Members - Vertical: Square steel tubing 2 by 2 inches with 1/8-inch wall thickness.

2. Frame Members - Horizontal: Rectangular steel tubing 2 by 4 inches with 1/8 inch wall thickness.

E. Frame Corner Construction:

1. Welded frame and 5/16-inch- diameter, adjustable truss rods for panels 5 feet wide or wider.

F. Infill: Comply with requirements for adjacent fence.

G. Hangers, Roller Assemblies, and Stops: Fabricated from galvanized steel or galvanized malleable iron.

H. Hardware: Latches and stops fabricated from steel or malleable iron. Fabricate latches with integral eye openings for padlocking.

I. Finish exposed welds to comply with NOMMA Guideline 1, Finish #3 - partially dressed weld with splatter removed.

J. Steel Finish: Same as fence framing.

2.5 STEEL AND IRON

A. Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.

C. Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

D. Uncoated Steel Sheet: Hot-rolled steel sheet, ASTM A 1011/A 1011M, Structural Steel, Grade 45 or cold-rolled steel sheet, ASTM A 1008/A 1008M, Structural Steel, Grade 50.

E. Castings: Either gray or malleable iron unless otherwise indicated.

1. Gray Iron: ASTM A 48/A 48M, Class 30.

2. Malleable Iron: ASTM A 47/A 47M.

F. Welded-Wire Mesh: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.6 COATING MATERIALS

A. Epoxy Zinc-Rich Primer for Uncoated Steel: Complying with MPI #20 and compatible with coating specified to be applied over it.

B. Polyurethane Intermediate Coat and Topcoat: Complying with MPI #72 and compatible with undercoat.

2.7 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Non-shrink Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.8 GROUNDING MATERIALS

A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Grounding Connectors and Grounding Rods: Comply with UL 467.

2.9 STEEL FINISHES

A. Finish steel fences and gates with either powder coating or high-performance polyurethane coating at CONTRACTOR’s discretion.

B. Surface Preparation: Clean surfaces according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

1. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.

C. Powder Coating: Immediately after cleaning, apply two-coat finish consisting of epoxy primer and TGIC polyester topcoat, with a minimum total dry film thickness of not less than 8 mils. Comply with coating manufacturer's written instructions.

1. Color and Gloss: As indicated by manufacturer's designations.

D. High-Performance Polyurethane Coating:

1. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils per applied coat, to surfaces that are exposed after assembly and installation, and to concealed surfaces.

2. Topcoats: Apply intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

a. Color and Gloss: As indicated by manufacturer's designations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions and according to the plans.

B. Post Setting:

1. Space posts uniformly at spacing indicated on Drawings.

2. Posts Set in Concrete Footings: Set posts in concrete fill into firm, undisturbed soil.

a. Excavation: Drill or hand-excavate holes for posts. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.

b. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete.

c. Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.

d. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

3. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch larger than outside diagonal dimension of post and at indicated post spacing.

a. Extend posts at least 5 inches into concrete.

b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.

c. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with grout.

3.3 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.4 GROUNDING AND BONDING

A. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

B. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

C. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

D. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.5 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

3.6 FIELD QUALITY CONTROL

A. Grounding-Resistance Testing: If required by the Authority, engage a qualified independent testing and inspecting agency to perform field quality-control testing.

1. Ground-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.

2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Authority promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.

3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.7 PROTECTION

A. Protect the work during the construction period so that it will be without any indication of use or damage at the time of acceptance.

END OF SECTION

SECTION 32 32 26

CRIB WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fabrication and installation requirements for modular concrete crib or steel crib retaining walls.

1.2 REFERENCES

A. AASHTO Standards:

1. M36 Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains.

2. M243 Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches.

1.3 SUBMITTALS

A. Shop Drawings or manufacturer's specifications showing components to be used, erection and component tolerances, overall layout, typical construction details, and construction procedures.

B. Project specific engineering design calculations for the wall.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 GENERAL

A. Concrete crib retaining walls consist of cribs composed of headers, stretchers, closers, and false headers. These components are held together principally by friction and are filled with crushed Rock or Soil. Cribs can be interlocked to increase base width and wall mass.

B. Metal bin retaining walls consist of a plurality of pairs of columns, one column of each pair is in the plane of the front wall and the other column is in the plane of the rear of the wall. The pairs of columns are spaced longitudinally with overlapping S-shaped facing and rear members (stringer). They are shaped transversely with overlapping U-shaped tie members (spacers).

C. Hot-dip galvanize all metal materials, including bolts, appurtenances, and connections. Refer to metal galvanizing requirements in Section 05 05 10.

2.2 MANUFACTURE OF CONCRETE CRIBWALL COMPONENTS

A. Concrete and Steel for Manufacture of Components:

1. Concrete: Class 4000, minimum cast-in-place, Section 03 30 00 “Cast in Place Concrete.”

2. Reinforcement: Steel, Section 03 20 00 “Concrete Reinforcing.”

B. Lengths and widths of component surfaces in contact with the molds during manufacture shall not depart from nominal approved design values by more than plus or minus 1/8 inch.

C. Distances between bearing surfaces shall not depart from the nominal design value by more than plus or minus 1/16 inch.

D. Bearing surfaces shall be parallel to within plus or minus 1/32 inch in the width of the units.

E. All components except false headers shall contain reinforcing steel that extends to within 1-1/2 inches of the end of the unit. In no case shall the diameter of the reinforcing steel be less than 3/8 inch.

F. All reinforcing steel shall be covered with at least 1-1/2 inch of concrete at the time of manufacture.

2.3 FABRICATION OF METAL BINS

A. Steel bin materials of the shapes and dimensions required.

B. Gage or thickness of wall construction members not less than 0.06 inch nominal.

C. When forming units, maintain a minimum-forming radius of 1 inch, or if units are formed with less than 1 inch radius, hot-dip galvanize after forming.

D. Assemble units into a continuous closed faced wall of connected bins.

E. Fabricate all units of the same nominal size so they are fully interchangeable. No drilling, punching, or drifting to correct defects in manufacturing will be permitted. Any units having holes improperly punched or galvanized will be rejected.

F. Field coat all buried portions and the back side of metal bin retaining wall units with an asphalt cement per AASHTO M243.

2.4 ACCESSORIES

A. Fill: Use only crushed Rock with a maximum diameter of three (3) inches or an approved soil fill which is free from organic matter and conforms to the gradation limits of 100 percent passing a three (3) inches sieve and not more than 15 percent passing a number 200 sieve.

B. Geotextile: Woven or nonwoven fabric, Section 31 05 19 “Geotextiles.”

PART 3 - EXECUTION

3.1 PREPARATION

A. Excavation, Section 31 23 16 “Excavation.”

B. Excavate for wall construction to 18 inches below finish ground line at the toe of the wall and slope the Excavation to the heel of the wall at the appropriate counter-batter as indicated in CONTRACTOR’s submitted design calculations.

C. The material under the base of the wall shall be either undisturbed native soil free from organic matter or an approved crushed aggregate base that is compacted equal to or greater than 90% of maximum dry density.

D. Install required geotextile, Section 31 05 19 “Geotextiles.”

3.2 BACKFILLING AND COMPACTION

A. Place fill carefully in lifts not exceeding 12 inches uncompacted depth and work between parallel crib wall components.

B. Soil used for wall fill, compact the fill equal to or greater than 90 percent of maximum dry density within the rear 2/3 of the face crib and in all multiple cribs.

C. Place and compact the backfill behind the cribs concurrently with the filling of the cribs.

3.3 ERECTION - GENERAL

A. Obtain site review by ENGINEER after wall and base cuts are completed and before start of wall construction.

B. Up to two (2) inches of sand or fine gravel may be used on top of the prepared base to adjust exact elevation of the base course of closers.

C. Handle component units carefully. Repair or replace damaged units.

D. Maintain all field tolerances to within plus or minus 1/2 inch in 10 feet of the nominal design tolerances.

E. Do not exceed the maximum height shown in the engineered wall calculation for each crib width shown.

F. In the construction of a wall on a curve, obtain the proper curvature for the face by the use of shorter stringers in the front or rear panels of retaining walls.

3.4 ERECTION – CONCRETE CRIB WALL

A. If cutting of the units requires the exposure of the ends of the reinforcing steel, coat the exposed steel with an epoxy or an asphalt cement.

B. If shims are required to maintain tolerances in wall, only shims made from asphaltic felt or fiberglass roofing material shall be permitted.

3.5 ERECTION – STEEL CRIB WALL

A. Bolt ends of steel stringers to corner columns by means of connecting channels.

B. Coat field cut of steel ends in accordance with AASHTO M36.

C. The wall height and depth may be varied. Do not exceed maximum dimensions shown for design selected. Two or more retaining walls may be incorporated in the same wall by the use of standard split columns to make the connection on the step-back.

END OF SECTION

SECTION 32 84 23

UNDERGROUND IRRIGATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Underground irrigation system complete with heads, valves, controls, and accessories.

B. Related Requirements

1. Section 01 60 01 “Buy America Requirements” for product purchasing requirements, including the provisions of 49 U.S.C. Section 5325(j) and 49 CFR Part 661 applying to this Project.

1.2 REFERENCES

A. ASSE Standards:

1. 1013 Reduced Pressure Principal Backflow Preventers.

B. ASTM Standards:

1. B88 Copper Pipe.

2. B687 Brass, Copper, and Chromium-Plated Pipe Nipples.

3. D1785 Poly (Vinyl Chloride) PVC Plastic Pipe, Schedules 40, 80, and 120.

4. D2464 Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings; Schedule 80.

5. D2466 Poly (Vinyl Chloride) (PVC), Plastic Pipe Fittings; Schedule 40.

6. D2672 Joints for IPS PVC Pipe Using Solvent Cement.

7. F656 Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

C. NFPA Standards:

1. 70 National Electric Code.

1.3 SUBMITTALS

A. Product Data: Manufacturer's technical data and installation instructions. Submit water efficiency calculations demonstrating the systems water efficiency.

B. Layout drawings and details illustrating piping layout to water supply location and type and coverage of heads, valves, piping circuits, controls, landscaping features, list of fittings and accessories.

C. Pipeline test report: Section 33 08 00 “Commissioning of Water Utilities.”

D. Operation and Maintenance Data: Section 01 78 23 “Operation and Maintenance Data:

1. Submit instructions covering full operation, care, and maintenance of system (and controls) and manufacturers parts catalog.

2. Include year-to-year schedule showing length of time each valve is to be open to provide determined amount of water, drain procedures, cleanout features, etc.

3. Instruct OWNER’s maintenance personnel how to operate controller and adjust sprinkler heads.

E. Manual Valve Key Operator:

1. Furnish 3 Gate valve key to fit each type of valve assembly.

2. Stop and waste valve key, rigid stee, with “T” handle, standing three (3) feet above ground when used and key end to fit stop and waste valve nut.

F. As-Built Drawings:

1. Provide detailed drawings of the completed irrigation system installation.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. Irrigation System: The arrangement of valves, controls, heads and accessories including lateral and mainline pipe systems.

B. Mainline Pipe: Pipe that carries water from point of connection at supply system to the valves.

C. Lateral Pipe: Pipe that carries water from the valves to the sprinkler heads or emitters.

1.7 PERFORMANCE REQUIREMENTS

A. Design Pressure: As indicated at the heads.

B. Location of Heads: Design location is approximate. Make adjustments as necessary to avoid plantings and other obstructions.

C. Water Coverage: Turf and other planting areas, 100 percent. Modify layout to obtain coverage and rate of application and to suit manufacturer's standard heads. Do not decrease number of heads indicated unless acceptable to ENGINEER.

D. Pipe Testing Schedule: Section 33 08 00 “Commissioning of Water Utilities.”

E. Flush pipe clean before head placement.

F. Leave system dry if work is Substantially Complete after October 15 unless otherwise acceptable to ENGINEER.

PART 2 - PRODUCTS

2.1 PIPE, FITTINGS, OTHER

A. Mainline Pipe, Lateral Pipe: PVC, Schedule 40 up to 2-1/2 inch diameter, then Class 200 for larger diameters, ASTM D1785:

1. Smaller than three (3) inches diameter, solvent welded, ASTM D2672.

2. 3 inches and larger diameter, threaded or mechanical joint.

B. Fittings: Solvent welded or threaded.

C. Sleeves, PVC: Four (4) inch minimum.

D. Riser:

1. Threaded schedule 80 PVC pipe 1/2 inch diameter. Length as required.

2. Half inch barbed swing pipe adapter.

E. Valve Fittings: PVC: Schedule 80 threaded.

F. Copper Pipe: Type K, ASTM B88.

G. Copper Fittings: Wrought or cast, ASTM B687.

2.2 VALVES

A. Manual Control Valve: Gate type with cast bronze body, resilient integral taper seat, non-rising stem, and fitted for key operation.

B. Manual Drain Valve: Ball type, 3/4 inch bronze body, with replaceable seat disc.

C. Automatic Control Valve:

1. Globe type, normally closed, fitted for manual flow adjustment.

2. Totally encapsulated low power replaceable solenoid.

3. High-strength rubber or synthetic rubber diaphragm.

4. Pressure regulating (set for site conditions).

D. Automatic Drain Valve: Designed to open for drainage when line pressure drops below three (3) psi. (NOT for use on mainline pipe.)

2.3 DRAIN SUMP

A. Sewer rock or pea gravel, Section 31 05 13 “Common Fill.”

2.4 BACKFLOW PREVENTER

A. Manufacturer's standard, State or OWNER approved, to suit sprinkler system and the following:

1. Reduced Pressure Principal Device: Above ground type, ASSE 1013.

2. Capable of being tested and serviced without removal from pipeline.

3. Body and caps constructed of bronze with wear and corrosion resistant internal parts complete with bronze quarter turn ball valves.

4. When underground irrigation system is designed for liquid fertilizer, provide a reduced pressure backflow prevention device. The drain to daylight must be a minimum of 12 inches below the bottom of the release valve for devices four (4) inches in diameter and smaller, or 12 inches plus the nominal diameter of the devices over four (4) inches in diameter.

5. Incorporate freeze protection mechanisms for backflow preventers in cold climates.

2.5 SPRINKLER HEADS

A. In General: Heads are placed to provide uniform coverage over entire area of spray indicated at available water pressure.

B. Pop-up Spray Head:

1. Fixed pattern with screw type flow adjustment and stainless-steel retraction spring.

2. Pop-up of 4, 6, and 12 inches.

3. Side and bottom inlets on six (6) and 12-inch heads.

C. Rotary Head:

1. Gear driven, high-impact plastic construction full circle and part circle design.

2. Built-in check valve.

D. Pop-up Impact Head:

1. High-impact plastic construction, full circle, part circle, with plastic clapper, and heavy-duty steel retraction spring.
2. Side or bottom inlet.
3. Built-in check valve required when used with more than three (3) feet of elevation change on the lateral line.
4. Plastic sprinkler nozzles, interchangeable.

E. Above-ground Impact:

1. Brass construction with stainless steel clapper.
2. Mounted above ground with no pop-up features.
3. Brass sprinkler nozzles interchangeable.

2.6 NOZZLES

A. Fixed Spray:

1. Radius pattern and gal/min as required.
2. Matched precipitation rates.
3. Stainless steel adjustment screw.
4. Threaded to match riser.
5. Pressure regulating: (Required when the psi at the sprinkler does not fall within the range recommended for its use). See manufacturer's specifications.
6. Filter Screen.

B. Bubbler:

1. Made of high-impact plastic.
2. Pressure compensating with adjustable flow and radius as required.
3. Threaded to match riser.
4. Attached to fixed riser or pop-up spray.
5. Filter screen.

2.7 VALVE BOX

A. Precast concrete or plastic with adequate hand room to operate small tools and provisions for locking cover to frame.

B. For drain pockets, ASTM size no. 2 gravel (2-1/2 inch) Section 31 05 13 "Common Fill."

2.8 DRIP TUBING

A. Self-cleaning, pressure compensating, polyethylene dripper line.

B. Dripper discharge: 0.6 to 0.9 gal/hr and choice of 12, 18 or 24 inch spacing.

C. Pressure compensation range from eight (8) to 60 psi.

2.9 LINE FLUSHING VALVE

A. Automatic cleaning, high impact, 1/2-inch diameter, plastic.

B. Maximum flow rate per flush valve: 15 gal/min.

C. Can be disassembled allowing for winterization blow-out.

2.10 AIR/VACUUM RELIEF VALVE

A. Brass body and cap and rated to 200 psi.

B. Temperature resistant silicone disc seat.

2.11 FILTER

A. Disk:

1. Corrosion resistant thermoplastic, threaded.
2. Multiple disk filter design: 120 mesh.
3. Shut-off valve.
4. Constructed of durable, non-corrosive components and equipped with O-ring seals.

B. “Y”:

1. Threaded inlet and outlet.
2. Polyester 0.01 mesh filter screen.
3. Durable, non-corrosive components and equipped with an O-ring seal.
4. Operating flow range of 1 to 15 gal/min with a pressure range of 10 to 150 psi.
5. Easy removable cap and screen.

2.12 SWING PIPE

A. Pipe: Polyethylene, flexible, rated for 80 psi.

B. Elbow: Barbed plastic suiting pipe diameter.

2.13 QUICK COUPLER

A. Heavy duty brass, one-piece body design.

B. Operating flow range of five (5) to 125 gal/min with a pressure range of 125 psi.

C. Brass key to match valve type and size.

D. Stainless steel spring.

2.14 JOINT PRIMER AND SOLVENT CEMENT

A. Refer to ASTM F656, and ASTM D2672 requirements.

2.15 VALVE BOX

A. Two-inch diameter, Schedule 40 PVC with removable cap, length as required.

2.16 TEFLON TAPE

A. For use on threaded joints. Quality grade, 0.004 inch.

2.17 AUTOMATIC CONTROL SYSTEM

A. General: Furnish low voltage system manufactured expressly for control of automatic circuit valves of underground irrigation systems. Provide unit of capacity to suit number of circuits.

B. Control Enclosure - External Applications: Manufacturer's standard weatherproof enclosure with locking cover, complying with NFPA 70.

C. Control Enclosure - Internal Applications: Manufacturer's standard with locking cover, complying with NFPA 70.

D. Wire:

1. Provide wire for connecting remote control valves to automatic controllers that is Type "UF", 600 volt, stranded or solid copper, single conductor wire with PVC insulation and bearing UL approval for direct underground burial feeder cable. Make all connections with UL approved type seal to make a waterproof connection. Bury wires in the same trench as the pipe where possible.

2. Provide wire with 4/64 inch insulation, minimum covering of ICC- 100 compound for positive weatherproofing protection. For wire sizes 14, 12, 10, and 8 use a single conductor solid copper wire, and for sizes 6 and 4 use stranded copper wire. Make control or "hot" wires red and all common or "ground" wires white.

3. Verify wire types and installation procedures conform to local codes.

Table 1 – Valve Wire Sizing Chart

Voltage at Controller	Wire Control Common	Maximum Allowable Length in Feet from Controller to Valves
		No. of Valves (Solenoids)

		1	2	3	4
14	14	2765	1309	846	549
14	12	3393	1608	1039	673
14	10	3962	1877	1213	783
12	12	4394	2082	1346	6872
12	10	5397	2557	1652	1071
12	8	6364	3018	1949	1263
10	10	6986	3311	2140	1387

E. Transformer: To convert service voltage to control voltage and in accordance with manufacturer's recommendations.

F. Circuit Control: Each circuit variable from approximately five (5) to 60 minutes. Include switch for manual or automatic operation of each circuit.

G. Timing Device: Adjustable, 24 hours and 14 days clocks to operate any time of day and skip any day in a 14-day period. Allow for manual or semiautomatic operation without disturbing preset mechanical operation.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Section 31 23 16 “Excavation.”

B. Excavate trenches for sprinkler system pipe to provide 18 inches of cover over Mainline Pipe and 10 inches over Lateral Pipe. Before excavating, establish location of all underground utilities and obstructions.

C. Trench for sprinkler system to ensure proper grades and slopes to drain points.

D. Barricade trenches within the right of way and along pedestrian routes that are left open overnight or that may be a hazard during construction, Section 01 55 26 “Traffic Control.”

3.2 INSTALLATION

A. General: Plans are diagrammatic. Proceed with installation in accordance with the following:

1. Run all Lateral and Mainline pipe as required. Within planting areas avoid conflict with trees. Where trenching is required in proximity to trees which are to remain, do not damage roots.

2. Install stop and waste valves, isolation valves, vacuum breakers, pressure reduction valves, and other equipment required by local authorities according to Laws and Regulations in order to make system complete.

3. Slope Lateral Pipe to drain.

4. After completion of grading, seeding or sodding, and rolling of grass areas, adjust heads to be flush with finished grades.

B. Piping:

1. Assemble all Lateral and Mainline Pipe in accordance with manufacturer's recommendations. Assure positive drainage.

2. At wall penetrations, pack opening around pipe with Section 03 61 00 “Cementitious Grouting” non-shrink grout. At exterior face, fill perimeter slot with backer rod and sealant. Repair below grade waterproofing and make penetration watertight.

3. Install PVC pipe in dry weather above 40 deg F Allow joint to cure a minimum of eight (8) hours before testing.

C. Sleeves:

1. Install sleeves before concrete work.

2. Under roadway, install PVC sleeve if cover over sleeve exceeds two (2) feet, otherwise use cast iron or ductile iron sleeve.

D. Control Valves:

1. Install remote control valves to manufacturer's recommendation.

2. Use Schedule 80 PVC pipe for nipples on valve header, length as necessary. Install valves one per each plastic valve box and provide 12 inches of expansion loop slack wire at all connections inside valve box.

E. Automatic Drains: Install per manufacturer's recommendations at low point of Lateral Pipes and Mainline Pipes.

F. Manual Drains:

1. Install per manufacturer's recommendations on upstream and downstream side of backflow preventers and at lowest point along Mainline Pipe.

2. Install by teeing down to 3/4-inch drain valve. Provide a drainage sump sized to receive volume of drain water.

3. Make manual drain valves accessible by installing an adjustable pipe sleeve to meet finished grade with locking valve marker lid flush with finish grade.

G. Quick-Coupling Valves: Install using 3/4-inch flexible lateral with galvanized elbow and riser. Locations as indicated.

H. Backflow Preventers:

1. Install assembly complete for sprinkler systems with two (2) drain valves and two (2) shut off valves per local Laws and Regulations, and manufacturer's requirements.

2. In below grade installations install assemblies with drain valves. Provide open box floor with gravel drain sump.

I. Valve Access Boxes:

1. Install over all remote control valves, manual control valves, zone shutoff valves, gate valves or globe valves. Valves to be installed using valve markers will not require access boxes.

2. Install boxes on level subgrade to proper grade and proper drainage.

3. Provide boxes with proper length and size extensions.

J. Automatic Controller:

1. Mount the panel enclosure so adjustments can be conveniently made by the operator.

2. Ground controller per local Laws and Regulations.

3. Make all control wire connections to automatic controllers.

4. Coordinate controller installation with electrical work.

K. Wire and Electrical Work: Use electrical control and ground wire suitable for sprinkler control cable of size indicated.

L. Sprinkler Heads, Emitters, Bubblers, Small Rotators (less than 10 gallons per minute):

1. Install with flexible lateral and spiral barbed PVC elbows and riser (length as required).

2. Install shrub spray heads a minimum of 12 inches above finished grade of plantings.

3. Install tree bubblers 1/2 inch below crown of tree roots.

4. Flush Lateral Pipe thoroughly. Remove all foreign materials prior sprinkler head installation.

M. Large Rotator Heads (10 gallons per minute or more): Install pressurized swings joints with O-ring seals.

N. Swivel Hose Elbows: Install brass swivel hose elbows, accurately machined pipe with hose threads and "O" ring seals.

3.3 FLUSHING AND TESTING

A. Mainline Pipe: Section 33 08 00 “Commissioning of Water Utilities.” Test at design pressure:

1. Flush pipe clean before pressure testing.

2. Pressure test in sections to expedite backfilling.

3. Notify ENGINEER 24 hours in advance of pressure testing pipe. Before backfilling and after air pockets have been vented from the lines, pressure test for three consecutive hours. Repair all leaks.

B. Lateral Pipe: Section 33 08 00 “Commissioning of Water Utilities.” Test at design pressure:

1. Pressure test in sections to expedite backfilling is permitted.

2. Flush pipe clean before head placement.

3. Provide one hundred (100) percent precipitation coverage.

3.4 BACKFILLING

A. Section 33 05 20 “Backfilling Trenches.”

B. Backfill to 6 inches above pipe with soil free of rocks over 1 inch diameter, debris, or organic matter. Backfill final four (4) inches with soil of like quality to adjacent areas.

C. Compact Trench backfill thoroughly to prevent settling damage to grades or plant materials. Repair at no additional cost to OWNER.

3.5 SURFACE FINISHING

A. Protect existing landscaping.

B. Landscapes: Restore landscaping as indicated and as follows where applicable.

1. Section 32 92 00 “Turf and Grass” for turf and grasses.

2. Section 32 93 13 “Ground Cover” for other ground cover.

C. Repair public and private facilities damaged by CONTRACTOR.

3.6 FIELD QUALITY CONTROL

A. Piping may be tested in sections to expedite backfilling.

B. Notify ENGINEER to schedule final inspection after irrigation system is completely installed and fully functional.

C. Make required field adjustment before inspection and changes after inspection as required by OWNER and ENGINEER.

END OF SECTION

SECTION 32 91 13

STRUCTURAL SOIL MIX

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil mix under urban sidewalks to enhance plant root growth and minimize flat work lifting or settlement from root growth.

1.2 REFERENCES

A. ASTM Standards:

1. C136 Sieve Analysis for Fine and Coarse Aggregates.

2. D1883 CBR (California Bearing Ratio) of Laboratory Compacted Soils.

3. F1647 Organic Matter Content of Putting Green and Sports Turf Root Zone Mixes.

1.3 SUBMITTALS

A. Mix Design. Identify:

1. Target proportions of mix ingredients.

2. Target CBR (California Bearing Ratio).

B. Source Sample: Submit gradation, CBR and pH test results.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 CRUSHED STONE

A. Material: Granite, sandstone, or light-weight borrow (limestone not allowed). River or pit run gravel not allowed.

B. Gradation: ASTM C136.

Sieve	Percent Passing
1 1/2	90 to 100
1	20 to 55
3/4	10 minimum

2.2 CLAY LOAM

A. Composition:

Material	Percentage
Gravel	Less than 5
Sand	20 - 45
Silt	20 - 50
Clay	20 - 40
Humus	2 - 5

B. Humus determined by ASTM F1647.

C. Peat may be used as an organic amendment to meet the humus requirements.

2.3 SOIL BINDER

A. Potassium propenoate-propenamide copolymer hydrogel.

2.4 MIX DESIGN

A. The following is provided as a guide in the development of a mix design:

1. Crushed Stone 100 parts.
2. Clay Loam 20 parts.
3. Soil Binder 0.03 parts.
4. Water Moisture content 10 percent.
5. pH Between 5.5 and 6.0.
6. CBR Target is greater than 50, ASTM D1883.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mixing may be done on site provided a uniform blend is produced before placement.

B. Excavation and limits as shown or identified by ENGINEER.

C. Layout and grading, Section 32 91 19 “Landscape Grading.”

D. Install in eight (8) inch thick lifts before compaction.

E. Compact to 95 percent relative to a standard proctor density, Section 31 23 26 “Compaction.”

END OF SECTION

SECTION 32 91 19

LANDSCAPE GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Landscape grading requirements.

2. Backfill materials.

B. Related Requirements:

1. Section 01 60 01 “Buy America Requirements” for product purchasing requirements, including the provisions of 49 U.S.C. Section 5325(j) and 49 CFR Part 661 applying to this Project.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Submit maximum laboratory dry density and optimum laboratory moisture content for:

1. Subgrade material, and

2. Each type of fill to be used.

1.4 QUALITY ASSURANCE

A. Do not change material sources, or aggregate without ENGINEER’s knowledge.

B. Reject backfill material that does not comply with requirements in this Section.

C. Landscape grading is aesthetic by nature and subject to continual monitoring and modification during the backfilling process. Work closely with ENGINEER particularly when grading and construction berms, channels, or other aesthetic considerations.

D. If requested, submit a quality control and testing report describing source and field quality assurance activities performed by CONTRACTOR and Suppliers.

1.5 ACCEPTANCE

A. Native material may be wasted if there is no additional cost to substitute material acceptable to ENGINEER.

B. For material acceptance refer to:

1. Common fill, Section 31 05 13.
2. Aggregate base courses, Section 32 11 23.
3. Cement treated fill, Section 31 05 15.

1.6 STORAGE

A. Safely stockpile backfill materials.

B. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.

C. Avoid displacement of and injury to Work while compacting or operating equipment.

D. Movement of construction machinery over Work at any stage of construction is solely at CONTRACTOR's risk.

1.7 SITE CONDITIONS

A. Do not place, spread, or roll any backfill material over material that is damaged by water. Remove and replace damaged material at no additional cost to OWNER.

B. Control traffic and erosion. Keep area free of trash and debris. Repair settled, eroded, and rutted areas.

C. Reshape and compact damaged structural section to required density.

1.8 WARRANTY

A. Any settlement noted in landscaped surfaces will be considered to be caused by improper compaction methods and shall be corrected at no additional cost to the OWNER.

B. Restore incidentals damaged by settlement at no additional cost to OWNER.

PART 2 - PRODUCTS

2.1 BACKFILL MATERIALS

A. Common fill, Section 31 05 13.

B. Cement treated fill, Section 31 05 15.

C. Aggregate base courses, Section 32 11 23.

D. Structural soil mix, Section 32 91 13.

2.2 WATER

A. Make arrangements for sources of water during construction and make arrangements for delivery of water to site.

B. Comply with local Laws and Regulations at no additional cost to OWNER when securing water from water utility company.

PART 3 - EXECUTION

3.1 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.”

B. Identify required line, levels, contours, and datum.

C. Stake and flag locations of underground utilities.

D. Upon discovery of unknown utility or concealed conditions, notify ENGINEER.

E. Verify stockpiled fill meets gradation requirements, areas to be backfilled are free of debris, snow, ice or water, and ground surface is not frozen.

F. If subgrade is not readily compactable secure written authorization for stabilization excavation and backfill. Refer to Section 31 23 16 “Excavation.”

3.2 PROTECTION

A. Protect existing trees, shrubs, lawns, existing structures, fences, roads, sidewalks, paving, curb and gutter and other features.

B. Protect above or below grade utilities. Contact utility companies to repair utility damage. Pay all cost of repairs.

C. Protect subgrade from desiccation, flooding and freezing.

D. Do not fill adjacent to structures until Excavation is checked by ENGINEER.

E. Do not use compaction equipment adjacent to walls or retaining walls that may cause wall to become over-stressed or moved from alignment.

F. Do not disturb or damage foundation perimeter drainage, foundation, damp-proofing, foundation waterproofing and protective cover, or utilities in trenches.

G. Restore any damaged structure to its original strength and condition.

3.3 LAYOUT

A. Maintain all benchmarks, control monuments and stakes, whether newly established by surveyor or previously existing. Protect from damage and dislocation.

B. If discrepancy is found between Contract Documents and site, ENGINEER shall make such minor adjustments in the Work as necessary to accomplish the intent of Contract Documents without increasing the Cost of the Work to CONTRACTOR or OWNER.

3.4 BACKFILLING

A. General: Conduct work in an orderly manner. Do not create a nuisance. Do not permit soil accumulation on streets or sidewalks. Do not allow soil to be washed into sewers and storm drains. Grading Intent: Spot elevations and contours indicated are based on the best available data. The intent is to maintain constant slopes between spot elevations. If a spot elevation is determined to be in error, or the difference in elevation between points change, then the minimum percentage of slope as a result of field adjustment of specific spot elevations is as follows:

1. Pavement Areas: 1 percent.

2. Concrete or Brick Areas: 0.30 percent.

3. Lawn or Planted Area: 0.75 percent.

B. Planted Surfaces:

1. Place backfill to a finished grade.

2. Grade slopes to provide adequate drainage after compaction. Do not create water pockets or ridges. Prevent erosion of freshly graded areas during construction until surfaces have been constructed and landscaping areas have taken hold.

3. Remove surface stones greater than 1 inch from finished grading.

C. Hard Surfaces: Place structural soil to depth specified.

3.5 MODIFIED BACKFILL LAYER METHOD

A. Backfilling Trenches, Section 33 05 20 “Backfilling Trenches.”

3.6 COMPACTION

A. Ninety-two (92) percent relative to a standard proctor density, Section 31 23 26 “Compaction”, unless indicated elsewhere.

3.7 SURFACE FINISHING

A. Restore paved surfaces, Section 33 05 25 “Pavement Restoration.”

B. Finish landscaped surfaces to match existing with grass, Section 32 92 00 “Turf and Grass” or with other ground cover, Section 32 93 13 “Ground Cover.”

1. Backfill areas to contours and elevations required. Do not use frozen materials.

2. Make smooth changes in grade. Blend slopes into level areas.

3. Remove surplus backfill materials from site.

4. Leave stockpile areas completely free of excess fill materials.

5. Slope grade away from building at a minimum of five (5) percent for ten (10) feet unless indicated otherwise.

3.8 CLEANING

A. Remove stockpiles from the site. Grade site surface to prevent free standing surface water.

B. Leave borrow areas clean and neat.

END OF SECTION

SECTION 32 92 00

TURF AND GRASS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seed and sod requirements.
2. Soil preparation and fertilizers.

1.2 REFERENCES

A. FS Standards:

1. OF 241 Fertilizers, Mixed, Commercial.

B. ASPA Standards:

1. Guideline Specifications for Sodding.

1.3 SUBMITTALS

A. Submit name of sod supplier or location.

B. Submit laboratory analysis of top soil, if requested by ENGINEER.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed in original containers showing analysis of seed mixture, percentage of pure seed, year of production, net weight, date and location of packaging. Damaged packages are not acceptable.

B. Strip sod no more than 24 hours before laying.

C. Deliver fertilizer in containers showing weight, chemical analysis, and name of manufacturer. Store fertilizer in a weatherproof location.

PART 2 - PRODUCTS

2.1 SEED

A. Furnish grass seed that is fresh, clean, and new crop composed of varieties indicated and tested to have minimum of 90 percent purity and minimum of 80 percent germination.

B. Use seed that conforms to applicable Laws and Regulations.

C. Do not use wet, moldy or otherwise damaged seed.

2.2 SOD

A. Obtain all shipments of sod from approved sources.

B. Mowed regularly and carefully maintained from planting to harvest to assure reasonable quality and uniformity.

C. Free of grassy and broadleaf weeds, and bare or burned spots.

D. Clean, strongly rooted sod of variety indicated.

E. Cut sod in pieces not exceeding 1 square yard. Limit depth of cut to 1/2 inch minimum and 1 inch maximum.

2.3 TOP SOIL

A. Section 31 05 13 “Common Fill.”

2.4 ACCESSORIES

A. Fertilizer: Uniform in composition, dry and free flowing. Comply with FS O-F-241. Provide nutrients required by soil analysis.

B. Mulching Material: Wood or wood cellulose fiber free of growth or germination inhibiting ingredients.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect existing underground improvements from damage.

B. Do not place turf and grasses until existing weeds have been removed and soil has been prepared.

C. Do not sow immediately following rain, when ground is too dry, too hard, or during windy periods without first loosening the surface.

3.2 GRADING

A. Establish finished grades after settling to provide adequate drainage so no water pockets or ridges will be created.

B. Till soil to a depth of four (4) inches and remove rocks and debris over two (2) inches diameter and any vegetation and weeds. Fine grade entire site to a smooth, loose, and uniform surface. Use native or approved imported topsoil and plant after proper preparation.

C. When subgrade has been established, roll areas to remove ridges and depressions so surface is parallel with finished grade. Limit weight of rolling equipment to 110 pounds minimum or 250 pounds maximum per square foot.

D. Site tolerances:

1. Total topsoil depth for lawns or grasses: Five (5) inches.

2. Elevation of topsoil relative to walks, hard surfaces or edges:

a. Seed Areas: 1/2 inch below.

b. Sod Areas: 1-1/2 inches below.

3. Slope away from building five (5) percent for 10 feet minimum. Fill low spots and pockets. High point of finish grade shall be at least six (6) inches below finish floor level.

3.3 FERTILIZING

A. Apply fertilizer in formulation and quantity required by soil analysis.

B. Apply after fine grading and mix thoroughly into upper two (2) inches of topsoil.

C. Do not apply grass seed and fertilizer at same time in same machine unless one step hydro seeding is used.

D. Lightly water to aid breakdown of fertilizer and to provide moist soil for seed.

3.4 SEEDING

A. Unless indicated otherwise, apply seed at a rate of five (5) pounds per 1,000 square feet evenly in two (2) intersecting directions. Rake in lightly.

B. Apply fine spray water immediately after each area has been sown.

3.5 ONE STEP HYDRO SEEDING

A. Unless indicated otherwise, on lawn areas apply seed at the rate of five (5) pounds per 1,000 square feet and fertilizer at the rate of 15 pounds per 1,000 square feet of area.

B. Mix seed and fertilizer with a specially prepared dyed wood cellulose fiber and water to form a slurry.

C. Mix slurry in tanks having continuous agitation so that a homogenous mixture is discharged hydraulically on area to be seeded.

D. Apply wood fiber mulch in suspension at a rate of 2,000 pounds per acre or as indicated otherwise.

3.6 TWO STEP HYDRO SEEDING

A. Make soil surface smooth, loose and uniformly fine texture before seeding. Do not prepare more ground than can be seeded in a work day period.

B. Mix fertilizer at a rate of 15 pounds per 1,000 square feet, with wood fiber mulch and water to form a slurry.

C. Maintain a well mixed fertilizer slurry in the mix tank.

D. Spray the fertilizer mixture at the rate of 2,000 pounds per acre.

E. Sow seed on fertilized areas at the rate of five (5) pounds per 1,000 square feet of area, in two (2) directions with a cyclone or other type mechanical seeder.

3.7 SEED PROTECTION ON SLOPES

A. Blankets: Section 31 25 00 “Erosion and Sedimentation Control.”

3.8 LAYING SOD

A. Maintain the sod moist, live, and in good condition to encourage immediate growth.

B. Comply with ASPA guidelines for sodding.

C. Lay sod on smooth, moist topsoil, working off planks if required. Rake to loosen and level before placing each course of sod. Ensure sod is not stretched or overlapped and all joints are butted tight. Place sod to break joints on ends. Keep length seams in a straight line.

D. Roll sod immediately after placing. Thoroughly water with a fine spray to a depth sufficient that the underside of the new sod and soil immediately below the sod are thoroughly wet.

E. On slopes two (2) horizontal to one (1) vertical and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at 2 feet maximum on center. Drive pegs flush with soil portion of sod.

3.9 RESTORATION

A. Restore paved surfaces, Section 33 05 25 “Pavement Restoration.”

B. Finish landscaped surfaces to match existing grass or with other ground cover, Section 32 93 13 “Ground Cover.”

3.10 CLEANING AND MAINTENANCE

A. Remove from site foreign materials collected during cultivation.

B. Dispose of cleanings.

C. Grass maintenance, Section 32 01 90 “Maintenance of Planting.”

END OF SECTION

SECTION 32 93 13

GROUND COVER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plants and ground cover requirements.
2. Bedding, topsoil, and temporary support.

1.2 REFERENCES

A. AAN Standards:

B. ANSI Standards:

1. Z60.1 American Standard for Nursery Stock.

C. FS Standard:

1. OF 241 Fertilizers, Mixed, Commercial.

1.3 SUBMITTALS

A. Submit samples of fertilizers and a complete listing of all plantings, origins and sizes.

B. All necessary inspection certificates for each shipment of plants as required by Laws and Regulations.

C. Schedule of planting times.

1.4 QUALITY ASSURANCE

A. Perform work in conformity with applicable requirements of AAN.

B. Obtain nursery stock and other plant materials from acceptable sources.

C. Provide plants free of disease and insects.

1.5 ACCEPTANCE

A. Ball of earth surrounding roots has not been cracked or broken.

B. Burlap, staves, and ropes required in connection with transplanting are installed.

C. Heeled in stock from cold storage not accepted.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Exercise care in digging, transporting, handling, and packing of all plants.

B. Handle plants so roots are protected at all times. If delivery is in open vehicles, cover entire load without causing overheating.

C. Deliver plant materials immediately before placement. Keep plant materials moist.

D. Protect balls from sun and wind by covering with soil or other suitable material if not planted immediately on delivery.

E. Store fertilizer in a weatherproof location such so its effectiveness will not be impaired.

1.7 WARRANTY

A. Warrant plantings through one year plus one continuous growing season. Replace any unsatisfactory or dead plantings within 10 days of written notice. Make corrections at no additional cost to OWNER.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide plants of normal growth and uniform height, according to species, with straight canes and well developed leaders, roots, and tops.

B. Provide plants of sizes indicated, Size stated in each case being interpreted to mean dimensions of plant as to stands in its natural position in nursery without straightening of any branches or leaders.

C. Provide legible labels attached to all plants, specimens, bundles, boxes, bales, or other containers indicating botanical genus, species, and size of each.

D. Plants cut back from larger sizes to meet Specifications shall be rejected.

E. Container growth deciduous shrubs will be acceptable in lieu of bailed and burlapped deciduous shrubs subject to limitations for container grown stock.

2.2 NATIVE GRASSES AND WILDFLOWERS

A. Unless indicated otherwise, provide the following mixture: 77 percent Festuca ovina duriuscula (Hard Fescue) and 23% Wildflower seeds of equal proportioned quantities of the following, Aster alpinus (Alpine Aster), Campanual carpatica 'Jacqueline' (Bluebells), Coreopsis grandiflora 'Sunray' (Dwarf Coreopsis), Eschschlzia californica (California Poppy), linum Lewisii (Blue Flax), Primula (While Primrose), Tagetes (Marigold), Viguiera Multiflora (Showy golden eye).

B. Purity of all seed types: 90 percent.

C. Germination of all seed types: 90 percent.

2.3 ORGANIC MULCH

A. Horticultural grade Class A decomposed plant material, elastic and homogeneous, free of decomposed colloidal residue, wood sulfur, and iron.

B. pH value of 5.5 to 7.5.

C. 60 percent organic matter by weight, moisture content not exceeding 15 percent, and water absorption capacity of not less than 300 percent by weight on oven dry basis.

2.4 ACCESSORIES

A. Fertilizer, FS O-F-241: Uniform in composition, dry and free flowing. Provide nutrients required by soil analysis.

B. Wrapping Materials: Quality burlap tightly tied around plant root system.

PART 3 - EXECUTION

3.1 PREPARATION

A. Plan to install materials during normal planting seasons for each type of landscape work required. Correlate planting time with maintenance periods and warranty.

B. Verify area to receive plants is to grade, all work is completed in the area, and topsoil has been placed. Follow Section 31 23 23 “Backfilling for Structures” grading requirements.

C. Do not proceed with work until unsatisfactory conditions have been corrected.

D. Examine grade, verify elevations, observe conditions under which work is to be performed, and notify ENGINEER of unsatisfactory conditions.

3.2 GRADING

A. Site tolerances:

1. 12 inches minimum total topsoil depth.

2. 2 inches below walks, hard surfaces or edges.

B. Do not expose or damage existing shrub or tree roots.

C. Slope away from building five (5) percent for 10 feet minimum. Fill low spots and pockets. High point of finish grade shall be at least six (6) inches below finish floor level.

3.3 FERTILIZING SEEDED AREAS

A. Apply fertilizer in formulation and quantity required by soil analysis.

B. Apply after fine grading and mix thoroughly into upper two (2) inches of topsoil.

C. Do not apply seed and fertilizer at same time in same machine unless one step hydro seeding is used.

D. Lightly water to aid breakdown of fertilizer and to provide moist soil for seed.

3.4 INSTALLATION

A. Place plant materials for orientation approval by ENGINEER before installation.

B. Set all shrubs slightly lower than finished grade. Use plant mix consisting of three (3) parts topsoil and 1 part organic mulch. Do not fill around stems. Carefully place and tamp plant mix soil to fill all voids.

C. Spread excess soil from excavated plant pits in surrounding planting beds.

D. Sow seed at the rate of 78 pounds per acre. Rake seed into soil and top-dress all seeded areas with 1/4 inch topsoil. Do not let seed installation be subject to damage by climatic conditions.

E. Restore pavements, grassed areas, planted areas, and other improvements damaged to a condition equal to original conditions.

3.5 CLEANING AND MAINTENANCE

A. Remove from site foreign materials collected during cultivation.

B. Dispose of cleanings.

C. Trees, plants, and ground cover maintenance, Section 32 01 90 “Maintenance of Planting.”

END OF SECTION

SECTION 32 93 43

TREE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Supply and install tree.

2. Site preparation and backfill requirements.

1.2 REFERENCES

A. APWA (Utah) Standards:

1. Plan 681 Tree.

B. ANSI Standards:

1. A300 Tree, Shrub and Other Woody Plant Maintenance Practices.

2. Z60.1 American Standard for Nursery Stock.

C. International Society of Arboriculture (ISA) Standards.

1.3 SUBMITTALS

A. Copy of CONTRACTOR’s notice to property owner. Format to be substantially as follows:

1.4 QUALITY ASSURANCE

A. Provide an ISA certified arborist to observe tree planting. Upon ENGINEER’s request, provide a copy of the arborist's ISA certificate and registration number on file with the State Division of Commercial Code.

B. Nursery: Use a company specializing in growing and cultivating trees with minimum three (3) years’ experience.

C. Installer: Use a company specializing in installing and planting tree.

D. Planting Plan: Correlate planting time with maintenance periods and warranty.

E. Rejection: Reject any tree upon the following basis:

1. Tree has cracked or broken ball of earth surrounding roots before or during process of planting.

2. Tree was cut back from a larger plant to meet Specifications.

3. Tree is not specified size.
4. Tree has been pruned improperly.
5. Tree has disease or insect infestations.
6. Tree was damaged during transplant.

1.5 ACCEPTANCE

A. Tree will be accepted not less than 60 days after planting, watering and successful growth.

1.6 WARRANTY

A. Vegetation establishment period, Section 32 98 00 “Vegetation Establishment Period.”

B. Include coverage of trees from death, unhealthy conditions, or if tree dies from poor planting practice. Replace any unsatisfactory or dead tree within 10 days of written notice.

C. Replacements: Provide tree of same size and species, planted in the next growing season, with a new warranty commencing on date of planting.

D. Additional Cost: All corrective work will be at no additional cost to OWNER.

1.7 MAINTENANCE

A. Period is until acceptance.

B. Maintain tree health immediately after placement.

C. Notify property owner of tree watering practice.

D. Trim off dead or broken branches. Remove clippings and dead branches from site.

E. Control disease.

PART 2 - PRODUCTS

2.1 TREE MATERIALS

A. Species and size specified, grown in climatic conditions similar to those in locality of Work with branching configuration and cane requirements required in ANSI Z60.1.

B. Provide tree of normal growth and uniform height, according to species, with straight trunk and well developed leaders, laterals and roots. Heeled in stock from cold storage not accepted.

C. Provide tree size indicated, (size being interpreted to mean dimension of tree as its stand in its natural position in nursery without straightening of any branches or leaders).

D. Provide legible labels attached to tree indicating botanical genus, species, and size.

2.2 SOILS

A. Backfill of Root Ball Pit: Native soil if not excessively rocky, compactable or clayey; otherwise amend at a rate of two (2) parts native soil to 1 part topsoil. Mix together thoroughly.

B. Topsoil: Section 31 05 13 “Common Fill.”

2.1 ORGANIC MULCH

A. Horticultural grade class A decomposed plant material, elastic and monogenous, free of decomposed colloidal residue, wood sulphur, and iron.

B. pH value of 5.5 to 7.5.

C. 60 percent organic matter by weight, moisture content not exceeding 15 percent, and water absorption capacity of not less than 300 percent by weight on oven dry basis.

PART 3 - EXECUTION

3.1 PREPARATION

A. Schedule tree planting during the optimal season for each species per local climate conditions.

B. Notify ENGINEER of unsatisfactory conditions.

3.2 EXCAVATION

A. Excavate only for depth of root ball.

B. In park strips adjacent to paved thoroughfares, the traditional round hole barely big enough to accommodate the root ball is not permitted. Excavate the site in the shape of a rectangle. Make excavated area width at least two (2) times diameter of tree root ball and length at least three (3) times its’ diameter:

1. Compact both sides of root ball parallel to street.

2. Loosen sides of planting site that are perpendicular to street.

C. In other landscaped areas, excavated area for tree planting at least three (3) times diameter of root ball.

D. Place plant materials for final orientation review by ENGINEER before backfilling root ball.

3.3 INSTALLATION

A. APWA Plan 681.

B. Remove wire baskets and twine from around root ball. If possible, remove all burlap material, or remove top 1/3 from root ball.

C. Maintain plant in vertical position. Eliminate voids and air pockets.

D. Remove all cardboard and twine from tree trunks.

E. Follow arborist's instructions.

3.4 PRUNING

A. Comply with ANSI A300 and directions of arborist.

3.5 PROTECTION

A. Do not touch directly or indirectly any overhead wire, cable, or power line.

B. Shelter the root ball. Do not let the root ball dry out.

C. Do not damage any irrigation line or emitter system.

D. Do not lift or maneuver the tree by the trunk.

E. Do no add gravel to the bottom of the hole.

F. Do not stake the tree unless carefully monitored by ENGINEER.

G. Do not compact the backfill.

H. Do not use grass clippings as mulch.

I. Do not over water, under water, over prune, paint or wrap the trunk, or fertilize during planting.

J. Do not forget to watch for people using the street or sidewalk while planting.

K. Do not over prune.

L. Do not allow grass, flowers, or vines to grow next to the trunk.

M. Protect roots and branches of existing trees.

N. Do not permit heavy equipment or stockpiling of materials or debris within the drip line. Do not permit earth surface within the drip line to be changed in any way except as required.

O. Replace existing trees damaged by construction operations at no additional cost to OWNER.

END OF SECTION

SECTION 32 98 00

VEGETATION ESTABLISHMENT PERIOD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Establish and care for plantings requiring watering.

2. Length of time CONTRACTOR is responsible to care for and establish plant materials.

1.2 REFERENCES

A. Not Applicable.

1.3 SUBMITTALS

A. Not Applicable.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. At ENGINEER's discretion conduct one or more inspections to determine condition of planting.

B. Acceptance occurs at end of establishment period or if OWNER accepts plantings in writing.

1.6 WARRANTY

A. Begins after irrigation system and plant installation inspections and acceptance have been completed and continues for one (1) calendar year, or indicated otherwise in the Contract Documents.

PART 2 – PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION

A. Establish healthy trees, shrubs, groundcovers, and turf.

B. Replace defective plant materials at no additional cost to OWNER.

C. CONTRACTOR will not be held responsible for damage due to acts of nature, vandalism, errant vehicles. Notify ENGINEER immediately if such event occurs.

3.2 PLANTS

A. Watering: As necessary to establish and maintain growth.

B. Keep weed-free plant basins and areas where mulch has been placed.

C. Prune broken or dead branches. Replace sub-standard sized plants that require excessive pruning to American Nurseryman Standards.

D. Repair non-functional water basins.

3.3 LAWNS

A. Apply 16-0-0 fertilizer (NPK ratio) in fall season following manufacturer's recommendation.

B. Control broadleaf weeds using selective herbicide.

C. Repair, reseed or resod areas showing rodent damage, erosion damage and other damage.

3.4 LAWN MOWING AND TRIMMING

A. Times are 7:00 to 10:00 a.m. or 5:00 to 8:00 p.m.

B. Height three (3) inches.

C. Clean cut with sharp blade.

3.5 IRRIGATION SYSTEMS

A. Repair installed pressurized irrigation systems to operate properly.

B. Repair erosion. settlement around Street Fixtures and irrigation system components.

C. Winterize system after October 15. Use compressed air at 100 psi only in pressurized systems. Do not put 100 psi air through drip circuits. Coordinate with ENGINEER.

D. Repair irrigation system components broken by CONTRACTOR.

END OF SECTION

Division 33 – Utilities

SECTION 33 01 30.73

RELINING PIPE CULVERTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Installation of a pipe within an existing pipe with or without restrained ends.

1.2 REFERENCES

A. Related Sections:

1. 01 55 26 “Traffic Control”
2. 33 05 06 “Polyethylene Pipe”

B. ASTM Standards:

1. F585 Insertion of Flexible Polyethylene Pipe into Existing Sewers.

1.3 SUBMITTALS

A. Traffic control plan per Section 01 55 26 “Traffic Control.”

B. Structural Data Sheet that includes the following:

1. Specific lateral or main line liner (by trade name).
2. Nominal and true inside and outside liner diameters.
3. Net wall area of liner in square inches per linear foot of pipe liner.
4. Liner structure must be capable of supporting the maximum fill height at the subject location.
5. Maximum ovality will be assumed at five percent.

C. Insertion Plan that includes, but is not limited to, the following:

1. Method of liner insertion (pulled or pushed).
2. Clearly identify manufacturer’s recommended method if pushing will be done.
3. Clearly identify the attachment method or pulling head being used to guide and ease the liner into place if pulling will be done.
4. Identify manufacturer’s recommended maximum pulling force for the attachment method or pulling head being used if pulling will be done.
5. Proposed length, access, and termination points for each run.

D. Manufacturer's procedures, recommendations, and guidelines that include:

1. Maximum external grouting pressure.

2. Maximum, minimum, and ideal installation temperature.

3. Liner joint assembly recommendations.

E. Manufacturer Certification.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTABLE

A. Not Applicable.

1.6 RELINING PIPE CULVERTS

A. Materials: The liner materials furnished shall be compatible for the intended installation method, service conditions, and hose pipe material.

B. Restrained Ends: Identify connections at each end of liner pipe that are designed to stop liner pipe shrinkage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Liner Pipe: Smooth wall HDPE having fused or manufactured commercial interlocking joints in each end of a pipe section, Section 33 05 06 "Polyethylene Pipe."

B. Grout: Hydraulic cement, pozzolans, sand, and water. Compressive strength of 250 psi at 28 days.

PART 3 - EXECUTION

3.1 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26 "Traffic Control."

B. Before placing pipe liner, verify liner will fit the host pipe. Use of a test head or "PIG" is recommended. Inform ENGINEER if host pipe has collapsed or is otherwise impassable.

3.2 LINER INSTALLATION

A. Host Pipe:

1. Clean host pipe before insertion.

2. Prevent sediment transport into waters of the state.

3. Host pipe may contain flowing water throughout the year. Dewater the pipe to facilitate liner insertion.

B. Liner:

1. Follow ASTM F585 and manufacturer's recommendations.

2. Minimize time insertion excavation area is open and exposed.

3. Remove sections of the inlet and outlet ends of the host pipe, fence, and other items not otherwise specified for removal to provide room for construction of an insertion area. Replace and install new items of the same size, shape, and material as those removed.

4. Where ends of liner pipe are to be restrained, install restraint devices.

C. Grout Annular Space:

1. Wait for temperature of host pipe and pipe liner to equalize before grouting.

2. Do not exceed manufacturer's rated collapse pressure of pipe liner.

3. Grout entire annular space along full length of the liner.

4. Prevent excess grout from entering downstream water courses.

5. Prevent movement from excessive buoyant forces on liner.

6. Trim grout flush and smooth with headwall.

3.3 RESTORE EXCAVATED AREA

A. Restore excavated or disturbed area to previous condition.

END OF SECTION

SECTION 33 05 01

ACRYLONITRILE-BUTADIENE-STYRENE (ABS) PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. ABS Pipe, fittings and joint materials.

1.2 REFERENCES

A. Related Sections:

1. 32 84 23 “Underground Irrigation Systems”
2. 33 05 20 “Backfilling Trenches”
3. 33 11 00 “Water Distribution and Transmission”
4. 33 31 00 “Sanitary Sewerage Systems”
5. 33 41 00 “Drainage Systems”

B. ASTM Standards:

1. C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
2. D1527 Acrylonitrile-Buta-diene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80.
3. D1788 Rigid Acrylonitrile-Butadiene-Styrene (ABS) Plastics.
4. D2235 Solvent Cement for Acrylonitrile-Butadiene-Stryene (ABS) Plastic Pipe and Fittings.
5. D2321 Underground Installation of Flexible Thermoplastic Sewer Pipe.
6. D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
7. D2468 Acrylonitrile-Butadiene- Stryene (ABS) Plastic Pipe Fittings, Schedule 40.
8. D2469 Acrylonitrile—Butadiene— Stryene (ABS) Plastic Pipe Fittings, Schedule 80.
9. D2680 Acrylonitrile-Butadiene-Stryene (ABS) and Po1y(Vinyl Chloride) (PVC) Composite Sewer Piping.
10. D2751 Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.

11. D2774 Underground Installation of Thermoplastic Pressure Piping.

1.3 SUBMITTALS

A. Provide material samples and product data for all pipe, fittings, and joint materials, including the manufacturer's instructions for storage, handling, and installation.

B. Provide certificates demonstrating compliance with the referenced ASTM standards.

1.4 QUALITY ASSURANCE

A. Evaluate pipes that show damage such as dents, cuts, cracks, breaks, fractures, or distortions. Recommend appropriate action. OWNER may require CONTRACTOR provide certification by a professional engineer competent in the structural design of the pipe material for action recommended.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Pipes, fittings, and joint materials should be delivered, stored, and handled in accordance with manufacturer's instructions. Any damaged or defected materials are to be replaced at the contractor's expense.

PART 2 - PRODUCTS

2.1 GRAVITY PIPE SYSTEMS

A. Material: Rigid ABS, ASTM D1788 based on short term tests. Select from the following:

1. Type I, Grade 1, cell (322).

2. Type IV, Grade 1, cell (133).

B. Pipe: ASTM D2751 for two (2) inches to 12 inches ABS pipe and ASTM D2680 for eight (8) inches to 15 inches ABS composite sewer pipe.

C. Fittings, ASTM D2751.

D. Joints:

1. Bell and spigot with solvent cement, ASTM D2235.

2. Mechanical-seal joint with gasket, ASTM C443.

E. Flattening, ASTM D2412: No evidence of splitting, cracking, or breaking.

2.2 PRESSURE PIPE SYSTEMS

A. Material: Rigid ABS, ASTM D1788 based on short term tests. Select from the following:

1. Type I, Grade 2, cell (522).

2. Type I, Grade 3, cell (355).

3. Type II, Grade 1, cell (445).

B. Pipe, ASTM D1527. For 1/8 inch to 12 inch pipe use schedule 40 or 80 for pressure rating required.

C. Joints:

1. Socket type with Iron Pipe Size (IPS) outside diameter, ASTM D2468 for Schedule 40 pipe and ASTM D2469 for Schedule 80 pipe.

2. Bell and spigot with solvent cement, ASTM D2235 or mechanical-seal joint with gasket, ASTM C443.

2.3 ACCESSORIES

A. Provide appropriate accessories required for a complete pipe system such as pipe adhesives, primers, couplings, cleanouts, and solvent cements as recommended by the manufacturer and in accordance with the referenced ASTM standards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assembly: Abide by manufacturer's instructions and the following. Use the more stringent provisions if there are any conflicts.

1. Pressurized Systems:

a. Water distribution and transmission, Section 33 11 00 “Water Distribution and Transmission.”

b. Underground irrigation, Section 32 84 23 “Underground Irrigation Systems.”

2. Gravity Systems:

a. Sanitary sewers, Section 33 31 00 “Sanitary Sewage Systems.”

b. Under drains and storm drains, Section 33 41 00 “Drainage Systems.”

B. Burial: Comply with Section 33 05 20 “Backfilling Trenches” and the following. Use the more stringent provisions if there are any conflicts.

1. ASTM D2774 for pressure pipe systems.

2. ASTM D2321 for gravity pipe systems.

3.2 INSPECTION AND TESTING

A. Inspect all pipes and fittings before installation to ensure they are free from visible defects. Defected materials should not be used and must be replaced.

B. Perform testing of the installed pipe system in accordance with local code and manufacturer's recommendations to ensure it is leak-free and functioning as expected.

3.3 REPAIR AND MAINTENANCE

A. Establish a regular inspection and maintenance schedule based on the manufacturer's recommendation to ensure the longevity and efficient operation of the pipe system.

B. Any damaged or leaking pipes identified during the maintenance checks should be replaced or repaired in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 33 05 02

CONCRETE PIPE AND CULVERT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Reinforced and non-reinforced concrete pipe and culvert, fittings and joint materials.

1.2 RELATED SECTIONS

03 61 00 “Cementitious Grouting”

04 05 16 “Masonry, Mortar, and Grout”

32 84 23 “Underground Irrigation Systems”

33 05 20 “Backfilling Trenches”

33 11 00 “Water Distribution and Transmission”

33 31 00 “Sanitary Sewerage Systems”

33 41 00 “Drainage Systems”

1.3 REFERENCES

B. AASHTO Standards:

1. HB-17 Highway Bridges.
2. LRFD Bridge Design Specifications, Customary U.S. Units.
3. M198 Joints for Concrete Pipe, Manholes, and Precast Box.
    a. Sections using Preformed Flexible Joint Sealants.

C. ASTM Standards:

1. C14 Concrete Sewer, Storm Drain, Culvert Pipe.
2. C76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
3. C118 Concrete Pipe for Irrigation or Drainage.
4. C150 Portland Cement.
5. C36l Reinforced Concrete Low-Head Pressure Pipe.

6. C4l2 Concrete Drain Tile.
7. C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
8. C444 Perforated Concrete Pipe.
9. C497 Testing Concrete Pipe, Sections, or Tile.
10. C505 Non-Reinforced Concrete Irrigation Pipe with Rubber Gasket Joints.
11. C507 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
12. C654 Porous Concrete Pipe.
13. C655 Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe.
14. C985 Non-reinforced Concrete Specified Strength Culvert, Storm Drain, and Sewer Pipe.
15. C1433 Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers. (Designed according to AASHTO BH-17).
16. C1479 Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.
17. C1504 Precast Reinforced Concrete 3 Sided Structures for Culverts and Storm Drains.
18. C1577 Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewer (Designed according to AASHTO LRFD).

D. AWWA Standards:

1. C302 Reinforced Concrete Pressure Pipe, Non-cylinder Type, for Water and Other Liquids.

1.4 SUBMITTALS

A. Precast box culvert design summary.

B. Manufacturer’s proof of certification.

1.5 QUALITY ASSURANCE

A. Pipe:

1. Remove and replace pipe that show exposed reinforcing steel, honeycomb or open texture.

2. Repair or replace reinforced concrete pipe if cracks are greater than 0.10 inch.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Pipes, fittings, and joint materials should be delivered, stored, and handled in accordance with the manufacturer's instructions. Any damaged or defective materials are to be replaced at the contractor's expense.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Provide type, class, strength and size of pipe and fittings required.

B. Concrete:

1. Use ASTM C150 or C1157 cement unless required otherwise.

2. Admixtures and pozzolans may be used only with approval.

C. Gravity Pipe System:

1. Reinforced Concrete Pipe: ASTM C76 or ASTM C655.

a. Within the trackway: Class V, Wall C per ASTM C76.

2. Non-reinforced Pipe: ASTM C14 in sizes up to 36" diameter and ASTM C985 for pipe up to 60" diameter.

3. Irrigation or Drainage Pipe: ASTM C118 or ASTM C505.

4. Drainage Tile: ASTM C412.

5. Perforated Pipe: ASTM C14 Type 1 Class 2 or ASTM C444.

6. Elliptical Pipe: ASTM C507.

7. Porous Concrete Pipe: ASTM C654.

8. Perforated Concrete Pipe: ASTM C444.

9. Precast Box Section Bridge: ASTM C1433 or ASTM C1577 as applicable.

10. Three Sided Culvert: ASTM C1504.

D. Low Head Pressure Pipe Systems: ASTM C361 or AWWA C302.

2.2 JOINTS

A. Use ASTM C443 rubber gasket bell and spigot type joints.

B. For box sections use tongue and groove joints with bituminous mastic joint sealant.

C. For elliptical sections use tongue and groove joints with bituminous mastic joint sealant, AASHTO M198.

D. Mortar: Mortar and Grout, Section 04 05 16.

2.3 SOURCE QUALITY CONTROL

A. Pipe and tile, ASTM C497.

B. Box sections, ASTM C1433.

C. Three sided culverts, ASTM C1504.

2.4 ACCESSORIES

A. Provide all necessary accessories such as joint sealants, grout, mastic, and others as recommended by the manufacturer and in accordance with the referenced standards.

PART 3 - EXECUTION

3.1 FACTORY FITTINGS

A. Fit all service tees and other miscellaneous fittings with an expanding plug.

B. Grout all fittings to provide a smooth interior and exterior surface.

C. When providing pipe or box sections specifically manufactured with branch connections, carefully shape and fit adjoining pieces to facilitate grouting. Grout all fittings to provide a smooth interior and exterior surface. Lateral pipe or sections shall not project beyond the inner surface of pipe.

D. Use epoxy adhesive grout, Section 03 61 00 as interface between new and existing concrete and piping materials.

3.2 INSTALLATION - PIPE AND FITTINGS

A. Assembly: Abide by manufacturer's instructions, ASTM C1479, and the following. Use the more stringent provisions if there are any conflicts.

1. Pressurized Systems:

    a. Water distribution and transmission, Section 33 11 00.

    b. Underground irrigation, Section 32 84 23.

2. Gravity Systems:

    a. Sanitary sewers, Section 33 31 00.

b. Under drains and storm drains, Section 33 41 00.

B. Burial: Comply with Section 33 05 20 and the following.

1. Place circular concrete pipe that contains elliptical reinforcing so that the reference lines designating the top of the pipes will not be more than five (5) degrees from the vertical plane through the longitudinal axis of the pipe.

C. Trenching and Backfill: The trenching, bedding, and backfill for pipe installations should be in compliance with the standards and regulations of the local governing authority, manufacturer's recommendations, and as specified in Section 31 23 00.

3.3 INSTALLATION - BOX SECTIONS

A. Assembly: Abide by manufacturer's instructions, and Section 33 41 00 for under drains and storm drain systems. Use the more stringent provisions if there are any conflicts.

1. Install per manufacturer’s instructions.

2. Provide a leveling course under box section. Use Sewer Rock unless specified otherwise.

3. Pull sections together using internal winches or tugger. Do not push box section together. Pushing causes joint misalignment.

4. Limit joint gap to maximum specified by manufacturer. Remove excess bituminous mastic joint sealant from interior box wall, floor, and ceiling.

B. Burial: Comply with Section 33 05 20.

3.4 INSPECTION AND TESTING

A. Perform a visual inspection of all pipes and fittings before installation to ensure they are free from visible defects. Defected materials should not be used and must be replaced.

B. Perform testing of the installed pipe system in accordance with local code and manufacturer's recommendations to ensure it is leak-free and functioning as expected.

3.5 REPAIR AND MAINTENANCE

A. Provide a regular inspection and maintenance schedule based on the manufacturer's recommendation to ensure the longevity and efficient operation of the pipe system.

B. Any damaged or leaking pipes identified during the maintenance checks should be replaced or repaired in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 33 05 03

COPPER PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The supply and installation of copper pipe, couplings, fittings, and joint materials for buried water utility systems.

1.2 REFERENCES

A. Related Sections:

1. 32 84 23 “Underground Irrigation Systems”
2. 33 05 20 “Backfilling Trenches”
3. 33 11 00 “Water Distribution and Transmission”

B. American Society of Testing and Materials (ASTM) Standards:

1. B32 – Standard Specification for Solder Metal.
2. B88 – Seamless Copper Water Tube.
3. B813 – Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper-Alloy Tube.
4. C800 Underground Service Line Valves and Fittings.

C. American National Standards Institute (ANSI) Standards:

1. B16.22 – Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

D. American Water Works Association (AWWA) C800 Underground Service Line Valves and Fittings.

1.3 SUBMITTALS

A. Required documentation including product data, shop drawings, test reports, and certifications.

1.4 QUALITY ASSURANCE

A. Reject cracked, chipped, crushed, dented, kinked, or otherwise unacceptable pipe.

1.5 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Copper Pipe and Tubing.

1. Types: K, L, M, or DWV copper tubing.

2. Shall conform with standards such as ASTM B88 for seamless copper water tubes.

B. Fittings.

3. Shall conform to standards such as ANSI/ASME B16.22 for wrought copper and copper alloy solder-joint pressure fittings.

C. Joining Materials.

4. Solder shall be lead free and conform with ASTM B32.

5. Flux shall conform with ASTM B813.

2.2 CONNECTIONS

A. Flared or compression.

B. Dielectric insulating unions for dissimilar connections.

C. Fittings shall be installed per AWWA C800.

PART 3 - EXECUTION

3.2 INSTALLATION

A. Assembly: Abide by manufacturer's instructions and the following. Use the more stringent provisions if there are any conflicts.

1. Pressurized Systems:

a. Water distribution and transmission, Section 33 11 00 "Water Distribution and Transmission."

b. Underground irrigation, Section 32 84 23 "Underground Irrigation Systems."

B. Burial: Comply with Section 33 05 20 "Backfilling Trenches."

END OF SECTION

SECTION 33 05 04

CORRUGATED METAL PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Corrugated metal pipe, fittings, and joining materials.

1.2 RELATED SECTIONS

33 05 20 – Backfilling Trenches

33 41 00 – Drainage Systems

1.3 REFERENCES

A. Related Sections:

1. 33 05 20 “Backfilling Trenches”
2. 33 41 00 “Drainage Systems”

A. AASHTO References:

1. M36 Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains.
2. M167 Structural Plate for Pipe, Pipe-Arches, and Arches.
3. M190 Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
4. M196 Corrugated Aluminum Alloy Culverts and Underdrains.
5. M197 Clad Aluminum Alloy Sheets for Culverts and Under drains.
6. M218 Zinc Coated (Galvanized) Steel Sheets for Culverts and Underdrains.
7. M219 Aluminum Alloy Structural Plate for Field Bolted Conduits.
8. M245 Precoated, Galvanized Steel Culverts and Underdrains.
9. M246 Precoated Galvanized Steel Sheet for Culverts And Underdrains.
10. M274 Steel Sheet, Aluminum-Coated (Type 2) by the Hot-Dip Process for Sewer And Drainage Pipe.
11. M289 Aluminum-Zinc Alloy Coated Sheet Steel for Corrugated Steel Pipe.

B. ASTM Standards:

1. D1187 Asphalt-Base Emulsions for Use as Protective Coatings for Metal.

C. FS Standards:

1. TT-P-636 Paint, Coating, Alkyd, Wood and Ferrous Metal.

1.4 SUBMITTALS

A. Repair damaged delaminated or scaled coating on pipe.

B. All materials to be tested and validated by an independent third-party testing facility.

C. Ensure that all pipe fittings meet or exceed the latest AWWA standards.

D. Manufacturer should have at least 10 years of experience manufacturing similar products.

1.5 QUALITY ASSURANCE

A. Reject pipe and fittings that do not meet requirements of this Section including, but not limited to, elliptical shaping; variation from a straight centerline; ragged edges; unevenly lined or spaced bolt holes; illegible brands, Abraided or scaled or broken spelter coatings; dents; bends in the metal; or uneven laps.

B. All materials to be tested and validated by an independent third-party testing facility.

C. Ensure that all pipe fittings meet or exceed the latest AASHTO and ASTM standards.

D. Manufacturer should have at least 10 years of experience manufacturing similar products.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. Nominal Diameter: Average distance measured from inside crest to inside crest of corrugations.

PART 2 - PRODUCTS

2.1 CORRUGATED PIPE

A. Type of Corrugations, AASHTO M218:

1. Annular or helical corrugations using lap joints with riveted or spot welded seams, or

2. Helical corrugations using continuous helical lock seams or ultra high-frequency resistance butt-welded seams.

B. Corrugated Steel Pipe, AASHTO M36: Select type of pipe corrugations, unless indicated:

1. Type I: Circular Section.

2. Type II: Noncircular Section.

3. Type III: Underdrain With or Without Perforations.

C. Corrugated Aluminum Pipe: AASHTO M196 or AASHTO M197 pipe as applicable. Select type of pipe corrugations, unless indicated.

D. Gage:

1. Circular Section Pipe: 16 minimum.

2. Arch Pipe: 14 minimum.

E. Corrosion and abrasion resistance requirements as per the regional climatic and environmental conditions.

2.2 STRUCTURAL PLATE PIPE

A. Galvanized Steel: Thickness, AASHTO M167.

B. Aluminum Alloy: Gage and tolerances, values in AASHTO M219.

C. Pitch and Depth of Corrugations: AASHTO M167 or AASHTO M219. Select pitch and depth unless indicated.

D. Lifespan: Minimum lifespan of 75 years under normal conditions.

2.3 COUPLING BANDS

A. Same base metal and coating as pipe, AASHTO M36 or M 245. Sixteen (16) gauge but not less than 2 gauge step lighter than pipe gage.

B. Provide circumferential and longitudinal strength to preserve pipe alignment, to prevent separation of pipe, to prevent infiltration of site fill material and to provide watertight joints.

C. Coupling bands should maintain integrity under a minimum load of 2x the expected operational load.

2.4 COATINGS AND LININGS

A. Zinc Coating: AASHTO M218.

B. Galvanized Coating: AASHTO M245.

1. Bituminous Coating and Lining: AASHTO M190. Coating thickness to be 0.05 inch measured on the crest of the corrugations. Linings, a minimum coating of 1/8 inch thickness above the crest of each corrugation:

a. Coating A. Fully bituminous coating.

b. Coating B. Half bituminous coating with paved-invert lining.

c. Coating C. Fully bituminous coating and paved-invert lining.

d. Coating D. Fully bituminous coating and 100 percent lining.

2. When fiber bonded bituminous coating is specified, embed fiber in the molten galvanizing before bituminous coating.

C. Polymer Coating: 10 mils thick minimum, AASHTO M245 or AASHTO M246:

1. Coating A. One side polymeric coating.

2. Coating B. Two side polymeric coating.

D. Aluminum Coating: AASHTO M274.

E. Aluminum-Zinc Coating: AASHTO M289.

F. All coatings and linings must pass a minimum 1000-hour salt spray (fog) test in accordance with ASTM B117.

2.5 FITTINGS AND ACCESSORIES

A. All fittings and bolts shall meet applicable specifications of pipe being joined. Use accessories and gaskets recommended by manufacturer.

B. When providing pipe specifically manufactured with branch connections, extend fittings to but not beyond inner surface of pipe.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assembly: Abide by manufacturer's instructions, Section 33 41 00 and the following. Use the more stringent provisions if there are any conflicts.

1. Tighten joint bands evenly.

2. Install elliptical pipe so the major or minor axis coincides with the proposed pipe alignment.

3. Do not cut coated pipe with a welding torch.

4. Coat aluminum pipe to prevent direct contact with concrete with an ASTM D1187 bituminous coating or an FS TT-P-636 zinc chromate primer.

B. Burial: Comply with Section 33 05 20 “Backfilling Trenches.”

3.2 REPAIR

A. Any damage to coatings and linings should be repaired as soon as possible to avoid potential corrosion and degradation. If there are signs of corrosion it shall be removed prior to the coating or lining repair. If there is degradation of the pipe, OWNERS written approval will be required for the material to be used.

B. Manufacturer to provide guidelines on the repair of damaged coatings and the criteria for replacement vs repair.

END OF SECTION

SECTION 33 05 05

DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The requirements for furnishing and installing ductile iron pipe (DIP), couplings, fittings, and joint materials for utility systems such as water supply and distribution, wastewater, and other related applications.

1.2 RELATED SECTIONS

32 84 23 – Underground Irrigation Systems

33 05 20 – Backfilling Trenches

33 11 00 – Water Distribution and Transmission

33 31 00 – Sanitary Sewerage Systems

33 41 00 – Drainage Systems

1.3 REFERENCES

A. American Water Works Association (AWWA) Standards:

1. C104 – Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. C110 – Ductile-Iron and Gray Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids.
3. C111 – Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
4. C115 – Flanged Ductile-Iron and Gray Iron Pipe with Threaded Flanges.
5. C150 – Thickness Design of Ductile-Iron Pipe.
6. C151 – Ductile-Iron Pipe, Centrifugally Cast.
7. C153 - Ductile-Iron Compact Fittings.
8. C600 – Installation of Ductile-Iron Water Mains and Their Appurtenances.

B. American Society of Testing and Materials (ASTM) Standards:

1. A536 – Standard Specification for Ductile Iron Castings.

2. F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.4 SUBMITTALS

A. Product Data: Manufacturer's technical data for ductile iron pipes and fittings.

B. Shop Drawings: Detailed drawings showing layout, sizes, and types of pipes and fittings.

C. Test Reports: Certified test reports demonstrating compliance with specified standards.

D. Manufacturer's Instructions: Detailed instructions for the installation of pipes and fittings.

1.5 QUALITY ASSURANCE

A. Repair damaged delaminated or scaled coating on pipe.

B. All materials to be tested and validated by an independent third-party testing facility.

C. Ensure that all pipe fittings meet or exceed the latest AWWA standards.

D. Manufacturer should have at least 10 years of experience manufacturing similar products.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 – PRODUCTS

2.1 Materials

A. Ductile Iron Pipe.

1. Conforming to ANSI/AWWA C151/A21.51.

2. Pipe Thickness: Determined by ANSI/AWWA C150/A21.50.

3. Pipe Length: Standard 18- or 20-foot lengths.

4. Coating: Asphaltic coating inside and out or as specified.

5. Lining: Cement mortar lining conforming to ANSI/AWWA C104/A21.4, unless otherwise specified.

B. Fittings.

1. Conforming to ANSI/AWWA C110/A21.10 or C153/A21.53.

2. Coating and Lining: Same as pipe or as specified.

C. Joints.

1. Rubber-Gasket Joints: Conforming to ANSI/AWWA C111/A21.11.

2. Flanged Joints: Conforming to ANSI/AWWA C115/A21.15.

D. Gaskets.

1. Elastomeric seals conforming to ASTM F477.

2.2 Buried Applications:

A. Class 52 or pressure class 350 psi ductile iron pipe, AWWA C151 with push-on joints, AWWA C111.

B. Class 250 fittings with AWWA C110 joints.

C. Coupler with mechanical joint fittings, AWWA C104, C110, and C1i1.

D. Rubber gasket slip-on pipe joints, AWWA Clll with gasket lubricant.

E. Bronze wedges with current capacity of 400 amps each for each joint as follows:

Pipe Diameter	No. of Wedges
less than 10”	2
10”	3
12”	4
greater than 12”	6

F. Above Ground Applications: As buried applications, except use bolted flanged fittings, AWWA C104, C110, and C115.

G. Corrosion and abrasion resistance requirements as per the regional climatic and environmental conditions.

H. Lifespan: Minimum lifespan of 75 years under normal conditions.

2.3 COVERINGS

A. Buried Mechanical Joints: Grease and eight (8) mil vinyl wrap plastic cover.

B. Coverings must pass a minimum 1000-hour salt spray (fog) test in accordance with ASTM B117.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assembly: Abide by manufacturer's instructions, AWWA C600, and the following. Use the more stringent provisions if there are any conflicts.

1. Pressurized Systems:

a. Water distribution and transmission, Section 33 11 00 "Water Distribution and Transmission."

b. Underground irrigation, Section 32 84 23 "Underground Irrigation Systems."

2. Gravity Systems:

a. Sanitary sewers, Section 33 31 00 "Sanitary Sewerage Systems."

b. Under drains and storm drains, Section 33 41 00 "Drainage Systems."

B. Burial: Comply with Section 33 05 20 "Backfilling Trenches."

1. Protect ferrous materials with polyethylene sheet that is at least six (6) mil thick. Tape wrap the sheet around the pipe.

C. All installation crews should have documented experience and training on the installation of the specified product.

D. Ensure all installation and assembly follow manufacturer's guidelines for proper joint assembly and torque requirements.

3.2 FIELD QUALITY CONTROL

A. Perform pressure testing of installed pipes to ensure no leaks.

B. Inspect all joints for proper installation and integrity.

C. Correct any deficiencies identified during inspection and testing.

D. Conduct a final inspection with the owner to ensure compliance with specifications and project requirements.

3.3 REPAIR

A. Any damage to coatings and linings must be repaired within a specified time period to avoid potential corrosion and degradation.

B. Manufacturer to provide guidelines on the repair of damaged coatings and the criteria for replacement vs repair.

3.4 CLEANING

A. Clean the interior of the piping system before commissioning.

B. Flush the system with clean water to remove any debris or contaminants.

3.5 PROTECTION

A. Protect installed pipes from damage during the remainder of construction activities.

3.6 DOCUMENTATION

A. Submit test reports, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed piping system.

END OF SECTION

SECTION 33 05 06

POLYETHYLENE PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The requirements for furnishing and installing polyethylene (PE) pipes for utility systems such as water supply, wastewater, and other related applications.

1.2 RELATED SECTIONS

32 84 23 “Underground Irrigation Systems”

33 05 20 “Backfilling Trenches”

33 11 00 “Water Distribution and Transmission”

33 31 00 “Sanitary Sewerage Systems”

33 41 00 “Drainage Systems”

1.3 REFERENCES

A. AASHTO Standards:

1. M252 Corrugated Polyethylene Drainage Pipe.
2. M294 Corrugated Polyethylene Drainage Pipe 300-1200 mm Diameter.
3. MP7-97 Corrugated Polyethylene Pipe — 1350 and 1500 mm Diameter.
4. NTPEP National Transportation Product Evaluation Program.

B. ASME Standards:

1. B1.1 Unified Inch Screw Threads (UN and UNR Thread Form), Supplement.

C. ASTM Standards:

1. A307 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
2. D2239 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Inside Diameter.
3. D2321 Underground Installation of Flexible Thermoplastic Sewer Pipe.
4. D2657 Heat Joining of Thermoplastic Pipe and Fittings.

5. D2774 Underground Installation of Thermoplastic Pressure Piping.

6. D3261 Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

7. D3350 Polyethylene Plastics Pipe and Fittings Materials.

8. F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

9. F1055 Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.

1.4 SUBMITTALS

A. Thermoplastic pipe manufacturer is compliant with AASHTO NTPEP for the diameter of pipe specified in the Contract Documents.

B. Submit test reports confirming compliance of materials and components with standards specified. Reports should come from an independent, accredited testing laboratory.

1.5 QUALITY ASSURANCE

A. Evaluate pipes that show damage such as dents, cuts, cracks, breaks, fractures, or distortions. Recommend appropriate action. ENGINEER may require CONTRACTOR provide certification by a professional engineer competent in the structural design of the pipe material for action recommended.

B. All materials to be tested and validated by an independent third-party testing facility.

C. Manufacturer should have at least 10 years of experience manufacturing similar products.

1.6 ACCEPTANCE

A. Not Applicable.

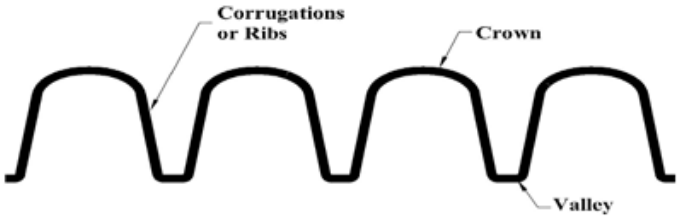
1.7 DEFINITIONS

A. Polyethylene Pipe (PE Pipe): Pipe made from high-density polyethylene (HDPE) material used for various utility applications.

B. Standard Dimension Ratio (SDR): Average diameter of pipe divided by the minimum wall thickness. The diameter may be either inside or outside measurement depending upon which standard is referenced.

C. Code Designation: A rating system by the Plastic Pipe Institute for smooth wall polyethylene pipe materials. The designation PE 3408 designates the type of plastic pipe (PE), the grade (34), and the hydrostatic design stress measured in units of 100 psi (08) at 23 deg C.

D. Corrugated Wall Pipe Classifications: Classifications are shown below. Types S and D have configurations either annular or helical.



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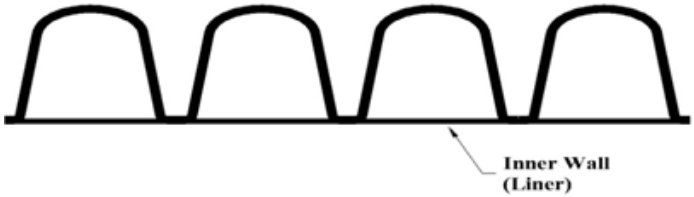
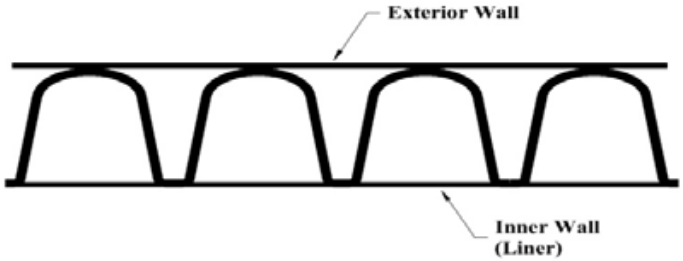


Type S



Type D

E. Porous Corrugated Wall Pipe: Classified as follows.

1. Type CP - This is Type C pipe with perforations.

2. Type SP - This is Type S pipe with perforations.

PART 2 - PRODUCTS

2.1 SMOOTH WALL PIPE SYSTEMS

A. Material: PE 3408 per ASTM D2239 with a minimum cell classification of 345434C per ASTM D3350.

B. Pipe: Smooth wall inside and out with an SDR or working pressure rating indicated or accepted by ENGINEER with exterior markings as follows:

1. ASTM Standard Number.

2. Pipe Size.

3. Class and profile number.

4. Production code.

5. Standard dimension ratio.

C. Fittings:

1. Resin same as pipe.

2. Working pressure same or greater than pipe.

D. Joints:

1. Thermally welded butt fusion, ASTM D3261.

2. Flanged, ASTM D2657.

3. Ultra-high molecular weight electo-fusion tape with a polyethylene coupler meeting ASTM F1055 requirements.

E. Expected Lifespan: Minimum lifespan of 50 years under normal conditions.

2.2 CORRUGATED WALL PIPE SYSTEMS

A. Material: Polyethylene, ASTM D3350 with a cell class as required in AASHTO M252, AASHTO M294 or AASHTO MP7-97.

B. Pipe: Type S or D unless indicated elsewhere.

C. Fittings:

1. Blow molded with cell class 335420C, ASTM D3350.

2. Rotational molded with cell class 213320C, ASTM D3350.

3. Shop or field remanufactured of the same material as the pipe.

D. Joints:

1. Bell and spigot with gaskets, ASTM F477. Foam type weather stripping not allowed.

2. Split corrugated couplings with plastic or stainless steel ties and leak resistant neoprene gasket.

E. Expected Lifespan: Minimum lifespan of 50 years under normal conditions.

2.3 NUTS AND BOLTS

A. Carbon steel machined heavy hex heads, Class 2 fit, ASTM A307; Grade B, threads, ASME B1.1.

B. All fasteners should be corrosion resistant or treated to ensure a long service life.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Assembly: Abide by manufacturer's instructions and the following. Use the more stringent provisions if there are any conflicts.

1. Pressurized Systems:

a. Water distribution and transmission, Section 33 11 00 "Water Distribution and Transmission."

b. Underground irrigation, Section 32 84 23 "Underground Irrigation Systems."

2. Gravity Systems:

a. Sanitary sewers, Section 33 31 00 "Sanitary Sewerage Systems."

b. Under drains and storm drains, Section 33 41 00 "Drainage Systems."

B. Burial: Comply with Section 33 05 20 "Backfilling Trenches" and the following. Use the more stringent provisions if there are any conflicts.

1. ASTM D2774 for pressure pipe systems.

2. ASTM D2321 for gravity pipe systems.

3. Protect ferrous materials with polyethylene sheet that is at least six (6) mil thick. Tape wrap the sheet around the pipe.

C. All installation crews should have documented experience and training on the installation of the specified product.

D. Endure proper alignment and grade of pipes.

E. Support and anchor pipes as required to prevent movement.

3.2 FIELD QUALITY CONTROL

A. Perform pressure testing, when applicable, of installed pipes to ensure no leaks.

B. Inspect all joints for proper installation and integrity.

C. Correct any deficiencies identified during inspection and testing.

D. Conduct a final inspection with the owner to ensure compliance with specifications and project requirements.

3.3 REPAIR

A. Repair damage such as dents, cuts, cracks, breaks, fractures, or distortions, Section 33 05 10.

B. Any damage to the pipe should be repaired within a specified time period to avoid potential leakage and damage.

C. Manufacturer to provide guidelines on the repair of damaged pipes and the criteria for replacement vs repair.

3.4 CLEANING

A. Clean the interior of the piping system before commissioning.

B. Flush the system with clean water to remove any debris or contaminants.

3.5 PROTECTION

A. Protect installed pipes from damage during the remainder of construction activities.

3.6 DOCUMENTATION

A. Submit test reports, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed piping system.

END OF SECTION

SECTION 33 05 07

POLYVINYL CHLORIDE PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The requirements for furnishing and installing polyethylene (PE) pipe, couplings, fittings, and joint materials for utility systems such as water supply, wastewater, and other related applications.

1.2 RELATED SECTIONS

32 84 23 “Underground Irrigation Systems”

33 05 20 “Backfilling Trenches”

33 11 00 “Water Distribution and Transmission”

33 31 00 “Sanitary Sewerage Systems”

33 41 00 “Drainage Systems”

1.3 REFERENCES

A. ASTM Standards:

1. D1784 Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
2. D2241 Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR - Series).
3. D2321 Underground Installation of Flexible Thermoplastic Sewer Pipe.
4. D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
5. D2564 Solvent Cement for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
6. D2729 Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
7. D2774 Underground Installation of Thermoplastic Pressure Piping.
8. D2855 Making Solvent Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
9. D3034 Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
10. D3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

11. D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

12. F656 Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

13. F679 Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

14. F949 Poly (vinyl Chloride) (PVC) Corrugated sewer Pipe with a Smooth Interior and Fittings.

B. AWWA Standards:

1. C110 Ductile-Iron and Gray-Iron Fitting, 3 inches Through 48 inches, for Water and Other Liquids.

2. C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution.

3. C905 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In.

4. C909 Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 in. Through 24 In., for Water, Wastewater, and Reclaimed Water Service.

1.4 SUBMITTALS

A. Product Data: Manufacturer's technical data for Polyvinyl Chloride pipes and fittings.

B. Shop Drawings: Detailed drawings showing layout, sizes, and types of pipes and fittings.

C. Test Reports: Certified test reports demonstrating compliance with specified standards.

D. Manufacturer's Instructions: Detailed instructions for the installation of pipes and fittings.

1.5 QUALITY ASSURANCE

A. Evaluate pipes that show damage such as dents, cuts, cracks, breaks, fractures, or distortions. Recommend appropriate action. ENGINEER may require CONTRACTOR provide certification by a professional engineer competent in the structural design of the pipe material for action recommended.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. Polyvinyl Chloride Pipe (PVC Pipe): Pipe made from polyvinyl chloride material used

for various utility applications

B. Standard Dimension Ratio (SDR): Outside diameter of pipe divided by wall thickness.

PART 2 - PRODUCTS

2.1 PRESSURE PIPE SYSTEM

A. Pipe: AWWA C900, C905, or C909 as applicable. Use outside diameters defined by ductile iron pipe sizes. Dimensions, class, SDR, and tolerances per ASTM D2241.

B. Compounds: Type 1, Grade 1, Class 12454A, ASTM D1784.

C. Joints:

1. Bell and spigot with flexible elastomeric seals, ASTM D3139. Use non-toxic lubricant.

2. Solvent weld, ASTM D2564.

D. Fittings (4 inch and larger): Ductile iron Class 250, ASTM C110.

2.2 GRAVITY PIPE SYSTEM

A. Pipe:

1. Solid smooth wall:

a. 4 to 15 inch diameter, ASTM D3034.

b. 18 to 27 inch diameter, ASTM F679.

2. Corrugated wall with a smooth interior, 4 to 10 inches diameter, ASTM F949.

B. Fittings: ASTM D1784.

C. Stiffness: 50 psi minimum when measured at five (5) percent deflection, ASTM D2412.

D. Additives and Fillers: Not to exceed 10 parts by weight; 100 parts of resin in the compound.

E. Joints: Bell and spigot with flexible elastomeric seals, ASTM D3212.

F. Flattening: No visual evidence of splitting, cracking, or breaking when flattened to 60 percent deflection, ASTM D2412.

2.3 PERFORATED PIPE SYSTEM

A. Pipe: Refer to gravity pipe products above.

B. Perforations: ASTM D2729.

C. Joints: Push-on, solvent weld or other.

2.4 SOLVENT WELDS

A. Primer, ASTM F656.

B. Glue, ASTM D2564.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assembly: Abide by manufacturer's instructions and the following. Use the more stringent provisions if there are any conflicts.

1. Pressurized Systems:

a. Water distribution and transmission, Section 33 11 00 "Water Distribution and Transmission", AWWA C900, C905, and C909.

b. Underground irrigation, Section 32 84 23 "Underground Irrigation Systems", and ASTM D2855.

2. Gravity Systems:

a. Sanitary sewers, Section 33 31 00 "Sanitary Sewerage Systems."

b. Under drains and storm drains, Section 33 41 00 "Drainage Systems."

B. Burial: Comply with Section 33 05 20 "Backfilling Trenches" and the following. Use the more stringent provisions if there are any conflicts.

1. ASTM D2774 for pressure pipe systems.

2. ASTM D2321 for gravity pipe systems.

3.2 FIELD QUALITY CONTROL

A. Perform pressure testing, when applicable, of installed pipes to ensure no leaks.

B. Inspect all joints for proper installation and integrity.

C. Correct any deficiencies identified during inspection and testing.

D. Conduct a final inspection with the owner to ensure compliance with specifications and project requirements.

3.3 CLEANING

A. Clean the interior of the piping system before commissioning.

B. Flush the system with clean water to remove any debris or contaminants.

3.4 PROTECTION

A. Protect installed pipes from damage during the remainder of construction activities.

3.5 DOCUMENTATION

A. Submit test reports, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed piping system.

END OF SECTION

SECTION 33 05 08

PRE-STRESSED CONCRETE PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete cylinder pipe in sizes 12 inches through 72 inches composed of a welded steel cylinder, steel joint rings welded to the cylinder, a centrifugally spun cement-mortar lining, a pretensioned rod wrapping helically wound around the steel cylinder under measured tension, and an exterior cement-mortar coating.

2. Couplings, fittings, and joint materials.

1.2 RELATED SECTIONS

03 30 10 “Concrete Placement”

1.3 REFERENCES

A. ASTM Standards:

1. C14 Concrete Sewer, Storm Drain and Culvert Pipe.

2. C33 Standard Specification for Concrete Aggregates.

3. C76 Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.

4. C150 Standard Specification for Portland Cement.

5. C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

6. C497 Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.

7. C507 Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe.

B. AWWA Standards:

1. C301 - Prestressed Concrete Pressure Pipe, Steel-Cylinder Type.

2. C302 - Reinforced Concrete Pressure Pipe, Noncylinder Type.

3. C304 - Design of Prestressed Concrete Cylinder Pipe.

1.4 SUBMITTALS

A. Product Data: Manufacturer's technical data for prestressed concrete pipes and fittings.

B. Shop Drawings: Detailed drawings showing layout, sizes, and types of pipes and fittings.

C. Test Reports: Certified test reports demonstrating compliance with specified standards.

D. Manufacturer's Instructions: Detailed instructions for the installation of pipes and fittings.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer must have a minimum of 5 years' experience producing similar products.

B. Installer Qualifications: Installer must have a minimum of 3 years' experience installing similar products.

C. Pre-Installation Meetings: Conduct a pre-installation meeting to review project requirements, installation procedures, and coordination with other trades.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in the manufacturer's original, unopened packaging with labels intact.

B. Store materials in a dry, protected location to prevent damage and contamination.

C. Handle materials to avoid damage. Do not drop or drag pipes and fittings.

D. Attach end covers to pipe stored either in the yard or in the field. Reject injurious drying out of concrete.

E. Stalls: Remain in place during storage.

F. Gaskets: Store in cool, well-ventilated place and protect from direct sunlight.

PART 2 - PRODUCTS

2.1 MATERIALS

G. Prestressed Concrete Pressure Pipe:

1. Conforming to AWWA C301 or AWWA C302.

2. Pipe Diameter: As indicated on the drawings.

3. Pipe Material: Concrete conforming to ASTM C76 and ASTM C150.

4. Reinforcement: High-strength steel wire for prestressing, conforming to AWWA C304.

5. Joints: Rubber gasket joints conforming to ASTM C443.

H. Fittings:

6. Conforming to AWWA C301 or AWWA C302.

7. Same material and pressure rating as the pipes.

8. Types: Tees, bends, reducers, and other special fittings as required.

I. Gaskets:

9. Elastomeric seals conforming to ASTM C443.

2.2 STEEL CYLINDER

A. Fabricated from either:

1. Hot-rolled carbon steel sheets: ASTM A570, Grade C, or ASTM A611, or ASTM A569 except that the maximum carbon content may be 0.25 percent and a minimum yield strength of 33,000 psi.

2. Plates: ASTM A283, Grade D.

3. Gauge of cylinder steel.

Pipe Size	Gauge	Pipe Size	Gauge
12” to 16”	16	54” to 57”	11
18” to 21”	15	60” to 63”	10
24” to 33”	14	66” to 69”	9
36” to 51”	12	72”	8

B. Seams: Fabricate sheets or plates into cylinders with longitudinal or helical seams. Where longitudinal seams are used, fabricate in courses, which may consist of two or more sheets or plates. Produce welds with a tensile strength at least equal to the specified minimum tensile strength of the sheet or plate. Cut test specimens from the cylinder and test per ASTM A370 when required.

C. Specified Diameter: The inside diameter of the concrete section.

D. Circumference of Steel Cylinders: Not to deviate from the design value by more than +3/16 inch for pipe sizes 16 inches and smaller or more than +1/4 inch for larger sizes.

2.3 STEEL CYLINDER AND ROD AREA

A. Total Cross-Section Area (cylinder plus rod reinforcement): Computed on the basis of a maximum stress of 16,500 psi, in the steel at the design pressure with no allowance for tensile strength of the concrete.

B. Rod Wrap: Not less than 7/32 inch diameter.

C. Maximum Center to Center Spacing Between Rods: No greater than 1-1/2 inches with cylinder thickness less than 14 gage nor greater than two (2) inches with cylinder thickness 14 gage and heavier.

D. Minimum Cross-Section Area of Rod Reinforcement per Lineal Foot of Pipe: Numerically equal to at least 1 percent of the nominal inside diameter of the pipe in inches.

E. Minimum Center to Center Spacing Between Rods: No closer than two (2) rod diameters.

F. Cross-Sectional Area of the Rod Reinforcement: Not to exceed 60 percent of the total required area of steel.

2.4 ROD WRAPPINGS

A. Rod Reinforcement: Steel grade 40, ASTM A615 except:

1. Bars: Plain round bars except the requirements of ASTM A615, Sec. 6, 7 and 14.3 shall not apply.

2. Intermediate Diameter Bars: Meet the requirements for the next smaller bar number designation.

3. Bars of Diameter Less Than No. 3: Meet the requirements for No. 3 bar.

B. Helically wind rods and space equally along the length of the cylinder and continue over the cylindrical portion of the bell ring.

C. Use a suitable device for stressing, measuring, and visibly indicating the tension in the rod during the winding operation. Hold the tension within 110 to 125 percent of the difference between the specified minimum yield strengths of the cylinder and rod. Continue the rod wrapping from end to end of the cylinder and weld to the joint rings. Lap weld the welded splices in the rod for a distance of four (4) rod diameters or butt weld in such a manner that the joint develops a tensile strength at least equal to the specified minimum strength of the rod. Test each butt welding to the stress of 25,000 psi tension.

2.5 JOINTS

A. Steel Joint Rings: Bell and spigot rubber gasket type, self-centering without the gasket supporting the weight of the pipe and the steel conforming to the requirements of AISI Steel Designation No. 1012.

B. Spigot Rings: Fabricated from a specially rolled section which includes a gasket groove. Proportion the groove that, upon proper closure of the joint, the gasket will be suitable compressed and will effect a watertight seal which provides for expansion, contraction and deflection.

C. Bell Ring Thickness Plus Rod Reinforcement Over the Bell: Provide a total cross-sectional area not less than 1/3 greater than that furnished for an equivalent length along the barrel of the pipe.

D. Sizing: Size both the bell and spigot rings to the same design diameter by expanding the rings beyond the elastic limit of the steel.

E. Tolerances:

1. Minimum bell ring thickness: U.S. standard 10 gage for pipe sizes 12 inches through 16 inches and 3/16 inch for larger sizes.

2. Circumference of the inside bell ring contact surface: Not to exceed the circumference of the outside spigot ring contact surface by more than 3/16 inch.

2.6 TESTING STEEL CYLINDERS

A. After each cylinder is completed, but before lining or coating, test hydrostatically to a minimum hydrostatic pressure which develops a circumferential tensile stress of not less than 20,000 psi and not more than 20,000 psi. Reweld cylinders that show any leakage under the test at the points of leakage and subject them to another hydrostatic test. Continue procedure until completely watertight under the required test pressure.

2.7 RUBBER GASKETS

A. Shape: Circular cross-section.

B. Gasket Compounds: Conform to the requirements of AWWA C200 consisting of first grade natural rubber, synthetic rubber, or a suitable combination thereof. Form and cure in such a manner as to be dense and homogenous with a smooth surface free from blisters, pits, and other imperfections.

2.8 CEMENT

A. Cement: Type II, ASTM C150 unless indicated otherwise.

2.9 AGGREGATES

A. Sand for Cement-Mortar: “Fine Aggregate”, ASTM C33, except that the gradation may be modified to provide a lining of optimum density.

2.10 CEMENT-MORTAR LINING

A. Cement-Mortar: One part cement to not more than three (3) parts fine aggregate by weight. Control water content to obtain dense, workable, durable mortar.

B. Spin the lining in the cylinder to obtain a nominal thickness of 1/2 inch for pipe sizes 12 inches through 16 inches and to a nominal thickness of 3/4 inch for pipe sizes 18 inches and larger. Use gage rings at the ends of the pipe to control the thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect the site and verify that conditions are suitable for installation.

B. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Excavate trenches to the required depth and width.

B. Provide bedding material as specified in the contract documents.

C. Ensure the trench bottom is smooth and free of rocks and debris.

3.3 INSTALLATION

A. Handle pipes and fittings carefully to avoid damage.

B. Inspect pipes and fittings for defects before installation.

C. Lay pipes and fittings in accordance with the manufacturer’s instructions.

D. Use appropriate tools and methods to cut pipes squarely.

E. Clean ends of pipes and fittings before joining.

F. Join pipes using rubber gasket joints or other specified methods.

G. Ensure proper alignment and grade of pipes.

H. Support and anchor pipes as required to prevent movement.

I. Backfill trenches in layers, compacting each layer to prevent settling.

3.4 Field Quality Control

A. Perform pressure testing of installed pipes to ensure no leaks.

B. Inspect all joints for proper installation and integrity.

C. Correct any deficiencies identified during inspection and testing.

3.5 Cleaning

A. Clean the interior of the piping system before commissioning.

B. Flush the system with clean water to remove any debris or contaminants.

3.6 CONSTRUCTION EQUIPMENT

A. Jackhammers: Less than nominal 30 pound class to prevent spalling.

B. Saws: Capable of cutting a minimum of three (3) slots simultaneously if more than 100 bars are to be placed in the Work. Less than 00, a walk behind saw may be used providing a template is used to ensure the slot locations are within the specified tolerances.

3.7 PREPARATION

A. Before the start of major operations, provide a test section consisting of at least 24 complete dowel bar retrofits.

B. In the presence of the ENGINEER and 24 hours after completing the test section randomly check dowel positioning by coring. Drill two cores, one on each end of a dowel bar to expose both ends and allow measurement for proper alignment. If the dowels are located incorrectly or air voids exist around the dowel bars, additional cores will be taken under ENGINEER's direction to determine severity.

C. CONTRACTOR will perform and patch all testing at no additional cost to OWNER.

D. Backfill all core locations using the acceptable dowel bar retrofit patching material.

3.8 INSTALLATION

A. Preparation: See APWA Plan 262 requirements.

B. Reservoir:

1. Saw, remove concrete, then sand blast. Remove dust, concrete slurry, and debris.

2. Skewed joints or cracks may require slots longer than the length shown in the plan. Increase length at no additional cost to OWNER.

3. If work is delayed for any reason reclean patching areas as necessary.

4. Apply CAS-5 silicone joint sealer to crack and joint in the reservoir walls and bottom.

C. Bars:

1. Place bars on chairs in middle of slab.

2. 1/2 inch clearance from bottom of reservoir.

3. Maximum allowable skew is 0.375 inches per 12 inches (3 percent) in horizontal and vertical planes.

D. Filler Board: Place in vertical plane of the transverse joint or crack. Fit tightly at reservoir bottom, sides and circumference of bar.

E. Concrete: Install and consolidate. Finish and apply curing and sealing compound.

F. After cure: Remove joint filler board across width of reservoir to a depth of two (2) inches. Seal joint with HAS-4 sheet, one component elastomeric type joint sealer.

3.9 PROTECTION AND REPAIR

A. General: All expenses are at no additional cost to OWNER.

B. Protection: Section 03 30 10. Protect down stream habitat from saw- cutting slurry.

C. Repair: Replace any non-functioning or damaged dowel bar retrofit.

END OF SECTION

SECTION 33 05 09

STEEL PIPE - LINED AND COATED

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cement mortar lined and coated steel pipe, couplings, fittings, and joint materials in sizes four (4) inches through 120 inches.

1.2 RELATED SECTIONS

33 05 20 “Backfilling Trenches”

33 11 00 “Water Distribution and Transmission”

1.3 REFERENCES

A. ASTM Standards:

1. A82 Steel Wire, Plain, for Concrete Reinforcement.
2. A283 Low and Intermediate Tensile Strength Carbon Steel Plates.
3. A370 Mechanical Testing of Steel Products.
4. A569 Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.
5. A570 Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
6. C33 Concrete Aggregates.
7. C150 Portland Cement.

B. AWWA Standards:

1. C200 Steel Water Pipe 6 In. and Larger.
2. C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. and Larger - Shop Applied.
3. C208 Fabricated Steel Water Pipe Fittings.
4. C303 Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pre-Tensioned, for Water and Other Liquids.

1.4 SUBMITTALS

A. Design Summary: Before any fabrication, submit a design summary for each size and class of pipe and line layout drawings or line schedules that show the location of each section of pipe and each special fitting to be furnished.

B. Shop Drawings of special fitting and outlets.

1.5 QUALITY ASSURANCE

A. Perform quality assurance tests required by AWWA C303.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DELIVERY, STORAGE AND HANDLING

A. Attach end covers to pipe stored either in the yard or in the field to prevent drying out of concrete.

B. Stalls: Remain in place during storage.

C. Gaskets: Store in a cool, well-ventilated place and protect from direct sunlight.

PART 2 - PRODUCTS

2.1 STEEL CYLINDERS

A. Fabricated from either:

1. Hot-rolled Carbon Steel Sheets: Conform to ASTM A570, Grades B, C, D, or E, or ASTM A569 except that the maximum carbon content may be 0.25 percent and a minimum yield strength of 33,000 psi.

2. Plates: Conform to ASTM A283, Grade C or D.

B. Seams: Fabricate sheets or plates into cylinders with longitudinal seams. Produce welds with a tensile strength at least equal to the specified minimum tensile strength of the sheet or plate. Cut test specimens from the cylinder and test per ASTM A370 when specified.

C. Specified Diameter: The inside diameter of the concrete section.

D. Circumference of Steel Cylinders: Not to deviate from the design value by more than +3/16 inch for pipe sizes 16 inches and smaller or more than +1/4 inch for larger sizes.

E. Test Steel Cylinders: Test hydrostatically to a minimum hydrostatic pressure which develops a fiber stress equal to 75 percent of the specified minimum yield strength of the steel. Reweld cylinders that show any leakage under test at the points of leakage and subject them to another hydrostatic test. Continue procedure until completely watertight under the required test pressure.

2.2 JOINTS

A. General: As indicated using one of the following procedures.

B. Bell and Spigot for Rubber Gasket: Fabricate the bell and spigot ends by either forming integrally with the steel cylinder or welding steel joint rings to the cylinder. Make the bell and spigot ends circular in shape and fabricated so that when the pipe is laid the joint will be self-centering with a gasket of sufficient size and cross-section to seal the joint. The difference in circumferential measurement between the outside circumference of the spigot and the inside circumference of the bell must not exceed 0.200 inch.

C. Belted Ends for Welding: Form a bell on the cylinder to accommodate the spigot. Make the spigot stub approximately 1-1/2 inches. Remove weld beads on the outside of the spigot and the inside of the bell to permit easy entry.

D. Plain Ends for Welding: Make both ends of pipe section plain and remove edge burrs.

E. Ends for Mechanical Couplings: Make ends of pipe section plain, grooved, or banded. Grind any weld beads on exterior of pipe flush with the pipe for a sufficient distance from the ends of the pipe to accommodate the coupling. Prepare grooved or banded ends to fit the type of mechanical coupling to be used.

2.3 CEMENT MORTAR

A. Cement: Type I or II, ASTM C150.

B. Sand: "Fine aggregate", ASTM C33, except the gradation may be modified to provide a lining of optimum density.

C. Cement-Mortar Mix: One part cement to not more than three (3) parts of sand by weight. Control water content to obtain dense, workable, durable mortar. Rebound may be reclaimed and used as aggregate.

2.4 RUBBER GASKETS

A. Shape: Circular cross-section.

B. Gasket Compounds: Conform to the requirements of AWWA C200 consisting of first-grade natural rubber, synthetic rubber, or a suitable combination thereof. Form and cure to be dense and homogenous with a smooth surface free from blisters, pits, and other imperfections.

2.5 INTERIOR LINING

A. Use gage rings at the ends of the pipe to control the spinning thickness. Spin the lining in the cylinder to obtain nominal thickness as follows:

1. 5/16 inch for pipe sizes four (4) inches through 12 inches.

2. 3/8 inch for pipe sizes 14 inches through 18 inches.

3. 1/2 inch for 20 inches and larger.

4. Other lining thickness, as specified in AWWA C205 or indicated.

B. After mortar has been placed in the cylinder, revolve at a speed that causes the cement-mortar to level out to a uniform thickness throughout the cylinder. Continue the spinning until the lining is thoroughly compacted and surplus water removed, and the finished lining is smooth and uniform throughout.

C. Lining Thickness Tolerance: Not more than 1 percent less or 25 percent more than the specified nominal thickness.

2.6 EXTERIOR COATING

A. Apply cement mortar exterior coating by mechanical means producing a dense, uniform finished coating adhering tightly to the pipe. Additional coating thickness may be specified to resist excessive external loads. Provide a minimum nominal coating applied over the cylinder as follows.

1. 1/2 inch for pipe sizes four (4) inches through 12 inches.

2. 5/8 inch for pipe sizes 14 inches pipe through 18 inches.

3. 3/4 inch for pipe sizes 20 inches and over.

B. Cement Slurry Coating: One bag of cement to not more than 10 gallons of water applied concurrent with the coating application to coat the steel assembly surface and the mortar-coating leading edge.

C. Steel Reinforcement: 14 gage cold-drawn steel wire conforming to ASTM A82, helically wound and embedded in middle third of the coating.

D. Suitably support the pipe during handing and curing to prevent damage to the lining coating.

2.7 CURING

A. Moist cure the lining for a minimum period of 24 hours after spinning. This may be accomplished by tightly sealing the ends of the cylinder with a waterproof membrane to retain the moisture in the mortar. Steam curing may be used in lieu of or in combination with moist curing on a time ratio basis of one (1) hour steam curing to four (4) hours moist curing.

B. Moist cure the completed pipe for six (6) days minimum. Steam curing may be used in lieu of moist curing.

C. Protect the mortar lining from temperatures below 40 deg F during the application and curing.

2.8 PIPE LENGTHS

A. 40 feet except where shorter lengths are required for fittings, curves, or closures.

2.9 BENDS AND SPECIFIC FITTINGS

A. Fabricate short radius bends or special fittings such as wyes, tees and crosses from previously tested steel cylinders, AWWA C208. Fabricate bends or special fittings at least equal in strength to the abutting pipe sections and line and coat with the same material as the pipeline. Obtain approval of design before fabrication.

B. Test all seams of bends or special fittings, except those seams previously tested as cylinders. Test seams by the air soap method or by the dye-check method. Repair any leaks by welding and retest the seam and recoat if required.

2.10 OUTLETS

A. Build outlets into the wall of the pipe, before testing, for blow-offs, branches, air valves, access manholes, etc. Provide cast or fabricated steel fittings of suitable design and securely weld to the cylinder before being coated. Reinforce the pipe cylinder, as necessary, for the required opening. Obtain approval of the design of such outlets before fabrication.

2.11 MECHANICAL COUPLINGS

A. All mechanical couplings should be suitable for the working pressures and temperatures expected in the system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assembly: Abide by manufacturer's instructions and Section 33 11 00 requirements for water distribution and transmission. Use the more stringent provisions if there are any conflicts.

1. Provide a maximum joint deflection on curved alignment by means of unsymmetrical closure of spigot into bell as per manufacturer's recommendation but not greater than the following:

   a. 3/4 inch for pipes 12 inches through 24 inches.

   b. 1 inch for pipes 27 inches through 72 inches.

2. Joints to be grouted inside and outside as per manufacturer's requirements.

B. Burial: Comply with Section 33 05 20 “Backfilling Trenches.”

3.2 TESTS

A. Leak Testing: After installation, perform a hydrostatic pressure test on the pipeline to check for leaks. Repair any leaks found.

B. Non-Destructive Testing: For welds, conduct radiographic or ultrasonic testing as per the applicable standards and project requirements.

3.3 REPAIR AND REPLACEMENT

A. Repair or replace any components found to be defective during testing or inspection.

3.4 DOCUMENTATION

A. Maintain a record of all tests and inspections performed and make available for review upon request.

3.5 FIELD QUALITY CONTROL

A. A third-party inspector or a representative of the Utah Transit Authority may periodically inspect the installation process to ensure compliance with this specification.

3.6 WARRANTY

A. Provide a warranty for the coated and lined steel pipe for a period of at least 12 months from the date of substantial completion or as per the contractual agreement.

END OF SECTION

SECTION 33 05 11

POLYPROPYLENE PIPE

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polypropylene (PP) pipe, fittings, joint requirements, and installation.

1.2 REFERENCES

A. AASHTO Standards:

1. M330 Polypropylene Pipe, 300 to 1500 mm (12 to 60 in.) Diameter.
2. NTPEP National Transportation Product Evaluation Program.

B. ASTM Standards:

1. D2321 Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow applications.
2. D2774 Underground installation of Thermoplastic pressure piping.
3. D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
4. F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
5. F2389 Pressure-rated Polypropylene (PP) Piping Systems.
6. F2736 6 to 30 in. Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe.
7. F2764 30 to 60 in. Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications.
8. F2881 12 to 60 in. Polypropylene Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications.

1.3 SUBMITTALS

A. Certificate showing product compliance per AASHTO NTPEP.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. Comigated Wall PP Pipe Classifications: Classified as Types C, Type S, and Type D. See Section 33 05 06 “Polyethylene Pipe.”

B. Porous Corrugated Wall PP Pipe Classification: Classified as follows.

1. Type CP - This is Type C pipe with perforations.

2. Type SP - This is Type S pipe with perforations.

PART 2 – PRODUCTS

2.1 PIPE

A. General: Pressurized and non-pressurized pipe may be required in a PP pipe system. ENGINEER to select if not specified elsewhere.

B. Sanitary Sewer Pipe:

1. Type S (corrugated single wall) per ASTM F 2736 (6-30") or

2. Type D (corrugated double wall) per ASTM F 2764 (30-60").

C. Storm Drain Pipe: Type S per ASTM F 2881 (12-60").

D. Under Drain Pipe: Type C, S, CP, or SP. Type CP and SP have Class 1 or Class 2 perforations indicated in AASHTO M 330. Provide Class 2 perforations if not indicated elsewhere. Class 1 perforations are for pipe intended to be used for under drains or combination under drain and storm drain. Class 2 perforations are for pipe intended to be used for under drains.

E. Pressurized Pipe:

1. Solid smooth wall, ASTM F 2389.

2. Working pressure rating indicated or accepted by ENGINEER.

3. Minimum exterior markings as follows.

a. ASTM Standard Number.

b. Pipe Size.

c. Production Code.

2.2 JOINTS

A. General: Provide joints with a working pressure at least equal to or greater than the pipe's working pressure and acceptable to ENGINEER.

B. Storm Drain and Sanitary Sewer Joints: Bell and spigot meeting ASTM D3212 with gasket that complies with ASTM F 477. Other joining methods such as external snap couplers, split couplers, solvent welding, etc. must meet performance requirements herein, manufacturer's recommendations, and ENGINEER's review.

1. When using bell retaining bands, use corrosive resistant materials such as fiberglass or stainless steel.

2. Foam type weather stripping not allowed.

C. Under Drain Joints: If not water tight, wrap with geotextile and tape to prevent detritus entry.

D. Pressurized Joints: ASTM F 2389.

2.3 FITTINGS

A. Supplied or recommended by pipe manufacturer.

B. Structural and pressure performance same as pipe or greater.

C. Vacuum test certified by manufacturer.

2.4 VALVES, MANIFOLDS, ETC.

A. ASTM F 2389.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Assembly: Abide by manufacturer's instructions and the following. Use the more stringent provisions if there are any conflicts.

1. Pressurized Systems:

a. Water distribution and transmission, Section 33 11 00 "Water Distribution and Transmission."

b. Underground irrigation, Section 32 84 23 "Underground Irrigation Systems."

2. Gravity Systems:

a. Sanitary sewers, Section 33 31 00 "Sanitary Sewerage Systems."

b. Under drains and storm drains, Section 33 41 00 "Drainage Systems."

B. Burial: Comply with Section 33 05 20 "Backfilling Trenches" and the following.

1. ASTM D2774 for pressure systems.

2. ASTM D2321 for gravity systems.

END OF SECTION

SECTION 33 05 14

UTILITY GRADE ADJUSTMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The requirements for the adjustment of utility grades, including manholes, catch basins, valve boxes, and other utility structures to the finished grade.
2. The raising, lowering, or change in slope of Street Fixtures.
3. Installation of Cover Collars.
4. This specification is NOT APPLICABLE to raising and lowering Street Fixtures that withstand internal pressure.
5. Adherence to safety protocols in accordance with local, state, and federal regulations, as well as site-specific requirements.

1.2 RELATED SECTIONS

03 30 00 “Cast in Place Concrete”

03 35 00 “Concrete Finishing”

03 61 00 “Cementitious Grouting”

32 01 17 “Sealing Cracks in Bituminous Pavement”

32 92 00 “Turf and Grass”

32 93 13 “Ground Cover”

33 05 25 “Pavement Restoration”

1.3 REFERENCES

A. APWA (Utah) Standards.

1. Plan 273 Frame and cover for monument Plan 360 Grade ring
2. Plan 362 Cover collar for storm drains
3. Plan 413 Cover collar for sanitary sewer manhole
4. Plan 574 Cover collar for water valve box

B. American Society of Testing and Materials (ASTM).

1. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
2. ASTM A48 - Standard Specification for Gray Iron Castings.
3. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
4. AASHTO M306 - Standard Specification for Drainage, Sewer, Utility, and Related Castings.

1.4 SUBMITTALS

A. Provide detailed schedule of utility grade adjustment works.

B. Submit list of materials along with their technical data sheets for approval.

C. Shop Drawings: Detailed drawings showing the location, dimensions, and adjustments for each utility structure.

D. Test Reports: Certified test reports demonstrating compliance with specified standards.

E. Manufacturer's Instructions: Detailed instructions for the installation and adjustment procedures.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer must have a minimum of 5 years' experience producing similar products.

B. Installer Qualifications: Installer must have a minimum of 3 years' experience performing utility grade adjustments.

C. Pre-Installation Meetings: Conduct a pre-installation meeting to review project requirements, installation procedures, and coordination with other trades.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. Box: A structure such as a valve box, meter box, monument box, fire hydrant box, electrical pull box, cleanout box or other like structure not intended for human entry.

B. Cover Collar: A concrete filled annular space between the frame of a Street Fixture and the adjacent pavement surface usually one (1) foot wide.

C. Extension Ring: A concrete or metal ring used to adjust surface elevations and surface cross slopes of Street Fixtures covers. Metal rings are used between metal frames and metal covers or grates. Concrete rings are used below metal frames or in the concrete structure below.

D. Manhole: A structure designed to permit human entry and working space inside and to confine and control the flow of pipe-conveyed fluids. These structures are collectively referred to as manholes regardless of composition, design, type or depth.

E. Street Fixture: The top of existing structures such as but not limited to Manholes, catch basin, sumps, inlets, valve boxes, meter boxes, monument boxes, and similar structure in a thoroughfare surface.

F. Vault: A structure intended for human entry containing electrical or telephone facilities or other like utilities.

PART 2 - PRODUCTS

2.1 PAVEMENT

A. Bituminous Concrete: Unless indicated otherwise in the Bid Documents or by ENGINEER, provide PG64-22, DM-1/2, 50 blow, product per Section 32 12 05.

B. Concrete: Class 4000 cast-in-place, Section 03 30 00 “Cast in Place Concrete.”

2.2 GROUT

A. Portland cement grout, Section 03 61 00 “Cementitious Grouting.”

B. Conforming to ASTM C270 for mortar.

C. Non-shrink grout for filling voids and ensuring stability.

2.3 FASTENERS

A. Provide suitable fasteners as required, compliant with local building codes and standards.

2.4 EXTENSION RINGS

A. Concrete or plastic: APWA Plan 360.

2.5 MANHOLE AND CATCH BASIN RINGS

A. Conforming to ASTM C478.

B. Material: Precast reinforced concrete.

C. Diameter and Height: As indicated on the drawings.

2.6 VALVE BOX ADJUSTMENTS

A. Conforming to ASTM A48.

B. Material: Gray iron or ductile iron.

C. Size: As indicated on the drawings.

2.7 ADJUSTMENT RINGS

A. Conforming to ASTM C891.

B. Material: Precast concrete, HDPE, or polymer concrete.

C. Height and Diameter: As required to achieve the finished grade.

PART 3 - EXECUTION

3.1 PREPARATION

A. Determine condition of existing incidental structure. Any item not reported damaged before construction shall be considered unbroken and must be replaced by CONTRACTOR at no additional cost to OWNER.

B. Provide Invert Cover over pipe in cleanout box to prevent gravel, concrete, or debris from entering pipeline.

C. Unless required otherwise, arrange for utility companies to adjust their own structures.

D. Coordinate all adjustments with requirements of affected utility company.

E. Prior to start of works, conduct risk assessment, and brief all personnel about safety measures to be adhered.

F. Remove existing frames, covers, and adjustment rings as necessary.

G. Clean the surface of the utility structures to ensure proper bonding of new materials.

H. Excavate around structures to provide adequate working space.

3.2 ADJUST STRUCTURE TO GRADE

A. Restrict excavation around structure to a minimum.

B. After structure adjustment, backfill void around structure and compact before paving or landscaping.

C. Apply mortar to inside and outside of concrete grade rings.

D. If the cone is cracked during construction, restack the manhole with shorter manhole sections and install a new cone at no additional cost to the OWNER.

E. In case of any variation or change from the initial plan, notify the OWNER and ENGINEER immediately and do not proceed with work until further instructions are received.

3.3 ADJUST COVER IN PAVEMENT SURFACE

A. Method A - Metal extension rings:

1. Use rings that lock together.

2. Set frame at desired elevation and cross-slope.

3. Seal joints between pavement and ring, Section 32 01 17 “Sealing Cracks in Bituminous Paving.”

B. Method B — Concrete extension rings:

1. Place concrete grade rings under frame or in structure riser shaft.

2. Set frame at desired elevation and cross-slope.

3. Provide 100 percent concrete support under frame. Do not use wood, bricks, concrete fragments, blocks or particles as support.

4. Grout seams between concrete rings and between frame and concrete rings.

C. Method C — Place Concrete:

1. Set frame at desired elevation and cross-slope.

2. Place concrete and provide 100 percent concrete support under frame.

D. Method D — Concrete Deck:

1. Remove existing concrete deck.

2. Reset steel rebar.

3. Set frame to grade, set forms.

4. Pour concrète. Provide complete concrète support under Street Fixtures.

3.4 INSTALL COVER COLLAR

A. Follow APWA Plans 362, 413, or 574 requirements as applicable.

B. Open annular space between pavement and Street Fixtures cover. Unless indicated otherwise, make space 12 inches wide.

C. Set concrete collar to 1/4 inch minimum to 1/2 inch maximum below bituminous concrete pavement surface and 1/4 inch below Portland cement concrete pavement surface.

D. Trowel finish, Section 03 35 00 “Concrete Finishing.”

3.5 SURFACE FINISHING

A. In new streets or overlays, adjust Street Fixture covers after paving is complete.

B. Restore paved surfaces, Section 33 05 25 “Pavement Restoration.”

C. Landscapes: Restore landscaping as indicated and as follows where applicable.

1. Section 32 92 00 “Turf and Grass” for turf and grasses.

2. Section 32 93 13 “Ground Cover” for other ground cover.

D. Repair public and private facilities damaged by CONTRACTOR.

3.6 FIELD QUALITY CONTROL

A. Inspect completed adjustments for compliance with project standards and requirements.

B. Arrange for testing and third-party inspections if required by the OWNER or the ENGINEER.

C. Conduct a final inspection with the OWNER to ensure compliance with specifications and project requirements.

3.7 CLEANING

A. Clean the area around the adjusted structures.

B. Dispose all surplus material, debris, etc. in an environmentally friendly manner as per local and state regulations.

3.8 PROTECTION

A. Protect adjusted utility structures from damage during the remainder of construction activities.

3.9 DOCUMENTATION

A. Submit test reports, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the adjusted utility structures.

END OF SECTION

SECTION 33 05 20

BACKFILLING TRENCHES

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backfill materials in trenches and backfilling requirements.

1.2 RELATED SECTIONS

01 55 26 “Traffic Control”

31 05 13 “Common Fill”

31 05 15 “Cement Treated Fill”

31 05 19 “Geotextiles”

31 23 16 “Excavation”

31 23 26 “Compaction”

32 11 23 “Aggregate Base Course”

32 92 00 "Turf and Grass”

32 93 13 “Ground Cover”

33 05 25 “Pavement Restoration”

33 08 00 “Commissioning of Water Utilities”

1.3 REFERENCES

A. APWA (Utah)Standards:

1. Plan 381 Trench backfill
2. Plan 382 Pipe zone backfill

B. ASTM Standards:

1. D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft' (600 kN-m/m')).
2. D1557 Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-1bf/ft' (2,700 kN-m/m3)).
3. D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

5. D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

6. D4832 Preparation and Testing of Soil-Cement Slurry Test Cylinders.

7. D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 DEFINITIONS

A. Bedding: That surface of the excavation or portion of the Pipe Zone below the pipe.

B. Pipe Zone: That zone in a backfilling operation which supports, and surrounds the pipe barrel, and extends to 1 foot above the top of the pipe barrel.

1.5 SUBMITTALS

A. Submit maximum laboratory dry density and optimum laboratory moisture content for:

1. Subgrade material, and

2. Each type of fill to be used.

B. Submit aggregate batch delivery tickets showing name of material source, serial number of ticket, date and truck number, name of Supplier, job name and location, volume or weight. And aggregate classification or Supplier’s identification code.

1.6 QUALITY ASSURANCE

A. Do not change material sources, or aggregate without ENGINEER’s knowledge.

B. Reject backfill material that does not comply with requirements in this Section.

C. If requested, submit a quality control inspections and testing report describing source and field quality control activities performed by CONTRACTOR and Suppliers.

1.7 STORAGE

A. Safely stockpile backfill materials.

B. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.

1.8 SITE CONDITIONS

A. Do not place, spread, or roll any backfill material over material that is damaged by water. Remove and replace damaged material at no additional cost to OWNER.

B. Control traffic and erosion. Keep area free of trash and debris. Repair settled, eroded, and rutted areas.

C. Reshape and compact damaged structural section to required density.

D. Restore any damaged structure to its original strength and condition.

E. Replace contaminated backfill at no additional cost to OWNER.

1.9 SEQUENCING

A. Coordinate backfilling operation with pipeline commissioning, Section 33 08 00.

1.10 ACCEPTANCE

A. General: Native material may be wasted if there is no additional cost to substitute material acceptable to ENGINEER.

B. Material: For material acceptance refer to:

1. Common fill, Section 31 05 13.

2. Aggregate base course, Section 32 11 23.

3. Cement treated fill, Section 31 05 15.

C. Lift Thickness: One test per lot.

D. Compaction: One test per lot. Verify density using nuclear tests, ASTM D2922. Compaction standard and Lot sizes as follows:

Table 1: Compaction Standard and Lot Size

Material	Proctor	Lot Size
Subgrade	Standard	200 linear feet
Common Fill	Standard	200 linear feet per lift 25 square feet of footing area per lift
Aggregate base course	Modified	200 linear feet per lift 25 square feet of footing area per lift

NOTES

A. Standard proctor, ASTM D698.

B. Modified proctor, ASTM D1557.

C. Lift thickness above pipe zone before compaction, 8 inches.

E. Flowable Fill Strength: Lot size is one (1) day production with sub-lots of 50 cubic yards or part thereof. Verify strength using cylinders, ASTM D4832.

F. Grade, Cross Slope: Measured at random locations.

1.11 WARRANTY

A. Correct any settlement of Trench backfill or structures built over Trench backfill at no cost to OWNER.

B. Restore structures damaged by settlement at no additional cost to OWNER.

PART 2 – PRODUCTS

2.1 BACKFILL MATERIALS

A. Common fill, Section 31 05 13. Granular material, CONTRACTOR's choice.

B. Aggregate base course, Section 32 11 23. Untreated base course.

C. Cement treated fill, Section 31 05 15. Use a flowable fill so vibration is not required.

D. Slag or bitumen bearing material NOT ALLOWED in trench.

2.2 WATER

A. Make arrangements for sources of water during construction and make arrangements for delivery of water to site.

B. Comply with local Laws and Regulations at no additional cost to OWNER when securing water from water utility company.

2.3 GEOTEXTILE FABRIC

A. Section 31 05 19. Use woven or non-woven stabilization-separation fabric. Select either moderate MARV or high MARV as needed.

2.4 IDENTIFICATION TAPE

A. Permanent, bright colored, continuous printed magnetic plastic tape, intended for direct burial service; not less than six (6) inches wide by four (4) mils thick. Tape shall read "CAUTION: BURIED INSTALLATION BELOW". Color as follows.

Color	Buried Installation Type
Red	Electric power lines, cables, conduit and lighting
Yellow	Gas, oil, steam, petroleum or gaseous materials
Orange	Communications, alarm, signal, cables or conduits
Blue	Potable water
Purple	Reclaimed water, irrigation and slurry lines
Green	Sewer and storm drain lines

PART 3 – EXECUTION

3.1 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26.

B. Identify required line, levels, contours, and datum.

C. Stake and flag locations of underground utilities.

D. Verify:

1. Backfill material meets gradation requirements.

2. Foundation walls are braced to support surcharge forces imposed by backfilling operations, areas to be backfilled are free of debris, snow, ice or water.

3. Trench bottom is not frozen.

E. If ground water is in the intended backfill zone, dewater.

3.2 SUBGRADE

A. Protect subgrade from desiccation, flooding, and freezing.

B. Before backfilling over Subgrade, get ENGINEER's review of Subgrade surface preparations.

C. If Subgrade is not readily compactable, get ENGINEER's permission to stabilize the subgrade:

1. Excavation for Subgrade stabilization is incidental work, Section 31 23 16.

2. Place geotextile fabric. Place acceptable fil1 in lifts. Compact.

3.3 PROTECTION

A. During installation or repair, plug end of pipe or fitting except when installing next section of pipe or fitting.

B. Movement of construction machinery over Work at any stage of construction is solely at CONTRACTOR's risk.

3.4 GENERAL BACKFILLING REQUIREMENTS

A. Avoid injuring and displacement of conduit, pipe and structures while compacting soil or operating equipment next to pipeline.

B. Place geotextile fabrics; Section 31 05 19 "Geotextiles."

C. Do not damage corrosion protection on pipe.

D. Repair or replace damaged pipe at no additional cost to OWNER.

E. Withdraw sheathing, shoring, piles, and similar supports as backfilling progresses. Backfill and compact all holes left by removals.

F. Provide sufficient water quality facilities to protect downstream fish and wildlife, and to meet State water quality requirements.

G. Water settling of trench backfill is not permitted. "Jetting" of trench backfill is prohibited.

3.5 PIPE ZONE

A. Follow APWA Plan 382 requirements.

B. Maintain uniform foundation along barrel of pipe with sufficient relief for joint connections.

C. Use backfill materials meeting pipe manufacturer's recommendations. Maximum backfill particle size is 3/4 inch for plastic pipe.

D. Do not permit free fall of backfill material that may damage pipe, pipe finish, or pipe alignment.

E. Except where piping must remain exposed for tests, fill pipe zone as soon as possible.

3.6 TRENCH ABOVE PIPE ZONE.

A. Follow APWA Plan 381 requirements.

B. Maximum lift thickness before compaction is eight (8) inches.

C. Fill unauthorized excavations with material acceptable to ENGINEER at no additional cost to OWNER.

D. Do not damage adjacent structures or service lines.

E. Install continuous identification tape directly over buried lines 18 inches below finished grade.

3.7 MODIFIED BACKFILL LAYER METHOD

A. At discretion of CONTRACTOR, backfill may be placed in thicker layers than indicated above subject to the following provisions:

1. CONTRACTOR proves the ability of proposed method to achieve specified average compaction density.

2. ENGINEER, on the basis of test results, approves the system in writing.

B. Should CONTRACTOR find it necessary to change the method or any part of it, including the source of material, or the rate of placing the material, obtain approval of ENGINEER, who may require a further trial area.

C. If testing shows a previously approved system is no longer producing the required degree of compaction, make changes to comply.

D. Where vibration effects are creating environmental problems, make changes to eliminate problems.

3.8 TOLERANCES

A. Compaction: Ninety-five (95) percent or greater relative to a standard or modified proctor density, Section 31 23 26 “Compaction.”

B. Lift Thickness (before compaction):

1. Eight (8) inches when using riding compaction equipment.

2. Six (6) inches when using hand held compaction equipment.

3. As proven in the modified backfill layer method.

C. Cement Treated Fill: Compressive strength targets are 60 psi in 28 days and 90 psi maximum in 28 days.

3.9 FIELD QUALITY CONTROL

A. Test trench backfilling until a compaction pattern acceptable to CONTRACTOR and ENGINEER is achieved. Continue random quality control compaction testing.

B. Perform in-place density tests using ASTM D6938 to confirm compaction requirements.

C. Inspect each layer of backfill for proper placement and compaction.

D. Correct any deficiencies identified during inspection and testing.

E. Conduct a final inspection with the OWNER to ensure compliance with specifications and project requirements.

3.10 SURFACE FINISHING

A. Provide temporary paved surfaces where trenches pass through roadways, driveway approaches or sidewalks.

B. Restore paved surfaces, Section 33 05 25 “Pavement Restoration.”

C. Landscapes: Restore landscaping as indicated and as follows where applicable.

1. Section 32 92 00 “Turf and Grass” for turf and grasses.

2. Section 32 93 13 “Ground Cover” for other ground cover.

D. Repair public and private facilities damaged by CONTRACTOR.

3.11 CLEANING

A. Remove stockpiles from site when work is complete. Grade site to prevent free standing surface water.

B. Leave borrow areas clean and neat.

3.12 PROTECTION

A. Protect backfilled areas from erosion and damage during the remainder of construction activities.

3.13 DOCUMENTATION

A. Submit test reports, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the backfilled trenches.

END OF SECTION

SECTION 33 05 23

STEEL CASING FOR UTILITY INSTALLATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The requirements for furnishing and installing steel casing for utility installations, including water, sewer, gas, and other utility lines.

1.2 RELATED SECTIONS

01 33 00 “Submittal Procedures”

33 05 20 “Backfilling Trenches”

1.3 REFERENCES

A. ANSI Standards:

1. C600 Installation of Ductile Iron Water Mains and their Appurtenances.

B. AWWA Standards:

1. C200 Steel Water Pipe – 6” and Larger.

2. C600 Installation of Ductile Iron Water Mains and their Appurtenances.

C. ASTM Standards:

1. A167 Type 316, Stainless Steel.

2. D638 Standard Test Method for Tensile Properties of Plastics.

3. D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

4. A139 - Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).

5. A252 - Standard Specification for Welded and Seamless Steel Pipe Piles.

6. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

1.4 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00 “Submittal Procedures.”

B. Product Data: Manufacturer's technical data for steel casing pipes and related materials.

C. Shop Drawings: Detailed drawings showing the layout, dimensions, and installation methods for steel casing.

D. Test Reports: Certified test reports demonstrating compliance with specified standards.

E. Manufacturer's Instructions: Detailed instructions for the installation of steel casing pipes.

F. The CONTRACTOR shall submit casing installation schedules including excavation, pipeline installation, and backfill operations.

G. The CONTRACTOR shall submit material list of PVC, RCP, and steel casing including diameter, thickness, class of RCP, and class of PVC casing and the type of casing insulators/spacers to be used.

H. The CONTRACTOR shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section.

I. Jacking and Boring Plan and Procedures:

1. Indicate locations of jacking and receiving pits relative to the track.

2. Describe method of jacking and boring including method of grouting annular space between casing and excavated soil.

3. For directional boring/drilling, submit complete specifications for the:

a. Operating and maximum pressures of liquid at the drilling head.

b. Water volume.

c. Type of reamer or cutting tool, size of holes/nozzles on the head, and method of head control machine to be used including:

J. Fourteen (14) days prior to initiating jacking or boring operations, submit an emergency remediation plan for approval by the engineer.

1. This plan shall identify methods to cut and remove rock, concrete or timber encountered at the boring face and methods to temporarily bulkhead the face.

2. CONTRACTOR must have the resources to execute this plan immediately available before this work is started.

1.4 QUALITY ASSURANCE

A. Quality control shall be performed in accordance with the General Provisions, except as modified herein.

B. All work shall be performed in the presence of the ENGINEER unless the ENGINEER has granted prior approval to perform such work in their absence.

C. The CONTRACTOR shall provide a qualified and experienced field supervisor who shall be responsible for ensuring the correct installation of casings according to the specified methods and materials.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 SYSTEMS DESCRIPTION

A. Unless otherwise noted in the Contract Documents or as approved in advance by the ENGINEER, the CONTRACTOR must use the following design criteria:

1. The depth of cover from base of rail to top of casing shall be 5 feet – 6 inches minimum or equal to the outer diameter of the casing, whichever is greater.

2. The depth of cover from the flow line of the right-of-way ditch to the top of casing shall be at least four feet for non-flammable substances in the carrier pipe and five feet for flammable or hazardous substances in the carrier pipe.

3. Jacking and receiving pits shall be at least 25 feet clear from the nearest track centerline.

4. Casing materials should be resistant to corrosion, chemical degradation, and environmental stress cracking.

PART 2 – PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall use the types of materials as designated herein for all required cased crossing construction.

2.2 MATERIALS

A. Casing:

1. The steel casing and steel split casing used shall comply with AWWA C 200 using steel conforming to ASTM A 570, Grade 45 in the sizes shown in the Contract Drawings. Minimum thickness shall be 0.25 inches.

2. HDPE casing shall meet the requirements of ASTM D3350, having a minimum cell classification of 335434C or 345434C.

B. Carrier Pipe: Carrier pipe shall be as indicated on the Contract Drawings.

C. Casing Insulators (Spacers): The carrier pipe shall be installed with casing insulators banded to it for guides and support as shown on the Contract Drawings. Insulators shall be a minimum of 12 inches long. A minimum of four insulators shall be installed on each carrier pipe length at a maximum spacing of 10 feet for steel or ductile iron and 6 feet for PVC, unless recommended otherwise by the manufacturer. The casing insulator shall be constructed of either galvanized steel with built up PVC lining and multi-segmented to attach firmly around the coated pipeline or pressure treated timber having a minimum dimension of 4" on a side. Insulators shall be fabricated for carrier pipe centered configuration with a minimum of two skids on top and two on the bottom. Insulator skids shall be sized to provide clearance of pipe bell, coupling, or retainer gland and not more than 1 inch of clearance from the top skids to the top of the casing. The steel casing insulators shall be manufactured by Calpico, Inc., Cascade CCS, 12 inches long or approved equal.

D. Spacers:

1. Material: Non-metallic or corrosion-resistant material to support the carrier pipe within the casing.

2. Size and Type: As specified in the project documents.

E. End Seals:

1. Material: Rubber or other suitable material to seal the ends of the casing and prevent soil and water ingress.

2. Size and Type: As specified in the project documents.

F. Cement Grout.

1. Cement grout shall consist of one part Portland Cement, three parts clean, well-graded sand and a minimum amount of water.

G. Lubricants: The contractor shall use a lubricant compatible with the casing material to minimize friction during the installation process. The lubricant shall be non-toxic, non-hazardous, and environmentally friendly.

PART 3 – EXECUTION

3.1 PREPARATION

A. General:

1. Inspect the site and verify that conditions are suitable for the installation of steel casing.

2. Do not proceed with installation until unsatisfactory conditions are corrected.

3. Conduct pre-installation surveys to identify existing underground utilities and obstacles.

4. Prepare entry and exit pits as required for the selected installation method.

5. Ensure that the casing pipe is free from damage and defects before installation.

6. The CONTRACTOR shall give the ENGINEER a minimum of seven days advance notice prior to the start of any excavation.

7. Unless otherwise provided, the CONTRACTOR shall furnish and install all fittings, closure pieces, jointing materials and all appurtenances as shown as required to provide a complete and workable installation. All fabrication and testing shall comply with the requirements listed herein.

8. The CONTRACTOR's attention is directed to the Contract Drawings which show the close proximity of adjacent structures and utilities to the proposed construction area. The CONTRACTOR shall be responsible for providing all shoring as may be required to maintain a safe excavation and shall at all times provide sufficient support and protection for existing structures and utilities at no additional expense to the UTA. Where required, the CONTRACTOR shall keep the size of the push pit to a minimum.

9. The CONTRACTOR shall carefully study the Contract Drawings and Specifications applicable to the work involved, contact the ENGINEER with any irregularities or difficulties, and be familiarized with the conditions, nature of excavation, and difficulties involved with installing pipe into casings and under the existing roadway.

10. Failure on the part of the CONTRACTOR to properly appraise the factors, conditions and difficulties involved in the performance of the work will not entitle extra compensation of any kind, nor relieve any obligation of executing all details of the work as specified and planned.

11. If the CONTRACTOR is not ready to place pipe in the casing upon completing casing installation, the casing ends shall be bulkheaded and push pits for pipe backfilled. All trenches in public streets, private property, and within UTA right-of-way shall be backfilled, temporary or permanent surfacing placed thereon, and the affected area reopened to traffic.

12. The CONTRACTOR shall be responsible for maintaining the specified line and grade.

3.2 INSTALLATION

A. Boring and Jacking:

1. Set up and calibrate boring and jacking equipment.

2. Bore the hole to the required diameter and length.

3. Install the steel casing by jacking it into place.

4. Monitor and control alignment and grade continuously.

B. Directional Drilling:

1. Set up and calibrate directional drilling equipment.

2. Drill a pilot bore along the designed path.

3. Enlarge the borehole to the required diameter using reamers.

4. Pull back the steel casing through the borehole.

5. Monitor and control drilling parameters to avoid ground heave or subsidence.

C. Open Cut:

1. Excavate the trench to the required depth and width.

2. Place the steel casing in the trench, ensuring proper alignment and grade.

3. Backfill and compact the trench in layers to the specified density.

D. Installation of Casing.

1. Steel casing shall be installed by the open trench method as shown on the Contract Drawings.

2. Allowable grade deviations in horizontal and vertical alignments shall be no greater than 0.2 feet per 100 feet in any direction over the length of the casing. Once construction is completed, the CONTRACTOR shall backfill the trench excavation with compacted material as described in Section 33 05 20 “Backfilling Trenches”, and as shown on the Contract Drawings. Backfill shall be placed in maximum 1-foot lifts and compacted before the next 1-foot is added.

E. Installation of Carrier Pipe: Installation of carrier pipe shall be in accordance with ANSI/AWWA C600. All joints of the carrier pipe within the casing shall be push-on or restrained joints as shown on the Contract Drawings and shall be in accordance with the specification sections for the type of pipe material installed. Application of coating to the joints shall be performed in accordance with the requirements as provided for elsewhere in these Specifications.

F. Applications of Cement Grout: After installation of the carrier pipe, the ends of the casing pipe shall be sealed with cement grout to prevent moisture from entering the casing. An alternative, required by Lehi City, TSSD, JVWCD and South Jordan City, is a Synthetic End Seal. Install according to manufactures recommendation.

G. Inspection: The CONTRACTOR shall inspect the installed casing for damage, misalignment, or other defects prior to installing the carrier pipe. Any defects identified shall be repaired or replaced as directed by the ENGINEER.

3.3 FIELD QUALITY CONTROL

A. The CONTRACTOR shall perform leakage tests on the installed casing and carrier pipe in accordance with the applicable industry standards and as approved by the ENGINEER.

B. The CONTRACTOR shall perform a deflection test on flexible casings, such as HDPE, to ensure that the installed casing has not exceeded the maximum allowable deflection specified by the manufacturer.

C. The CONTRACTOR shall provide the ENGINEER with the results of all tests performed for review and approval.

D. Perform inspections to ensure proper alignment, grade, and installation of the steel casing.

E. Inspect all joints and fittings for proper installation and integrity.

F. Correct any deficiencies identified during inspection and testing.

G. Conduct a final inspection with the Architect/Engineer to ensure compliance with specifications and project requirements.

3.4 CLEANING

A. Remove excess material and debris from the site.

B. Restore the surface to match the surrounding area, including final grading and seeding as required.

3.5 PROTECTION

A. Protect installed steel casing from damage during the remainder of construction activities.

3.6 DOCUMENTATION

A. Submit test reports, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed steel casing.

END OF SECTION

SECTION 33 05 23.35

TRENCHLESS UTILITY INSTALLATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section includes the requirements for trenchless installation of utilities using methods such as directional drilling, pipe jacking, microtunneling, and other trenchless techniques.

1.2 RELATED SECTIONS

03 61 00 “Cementitious Grouting”

31 05 15 “Cement Treated Fill”

31 23 16 “Excavation”

33 05 02 “Concrete Pipe and Culvert”

1.3 REFERENCES

A. ASTM Standards:

1. A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

2. F1962 - Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings.

3. F1417 - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.

4. D3839 - Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

5. D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

B. OSHA Standards.

1.4 SUBMITTALS

A. A step by step plan of jacking operations, safety measures, and provisions for anticipated risks.

B. Details of jacking pit bracing, casing or conduit, and jacking head to be used.

C. Dimensions and support of pilot tunnel (if used).

D. Details of steel rails in pilot tunnel (if used), including true line and grade.

E. Product Data: Manufacturer's technical data for pipes, fittings, and trenchless equipment.

F. Shop Drawings: Detailed drawings showing the layout, dimensions, and methods for trenchless installation.

G. Test Reports: Certified test reports demonstrating compliance with specified standards.

H. Manufacturer's Instructions: Detailed instructions for the installation and fusion of pipes and fittings.

I. Copy of applicable permits from agency having jurisdiction.

1.5 QUALITY ASSURANCE

A. All activities must be performed by personnel trained in trenchless utility installation.

B. All materials and equipment used must comply with applicable standards and regulations.

C. Pre-Installation Meetings: Conduct a pre-installation meeting to review project requirements, installation procedures, and coordination with other trades.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 PERFORMANCE REQUIREMENTS

A. Jack conduit to line and grade indicated. Modify jacking operation to correct any deviation. Correct misalignment in line or grade at no additional cost to OWNER.

B. Methods and equipment used in jacking casing or conduit are CONTRACTOR's choice but must be submitted to the OWNER prior to installation.

C. Use workers experienced in jacking operations.

PART 2 - PRODUCTS

2.1 STEEL CASING

A. ASTM A53, Grade B steel pipe for jacking operations, minimum wall thickness of 0.375 inch, minimum yield stress of 42,000 psi. Use a casing with a diameter equal to the outside bell diameter of the pipe plus four (4) inches minimum.

B. Fillet weld joints continuous around casing and reinforce joints to withstand jacking operations.

2.2 CONCRETE PIPE

A. Section 33 05 02 “Concrete Pipe and Culvert.” When concrete pipe is to be jacked, use a pipe section designed to support the superimposed loads and the loads that may be placed upon the pipe during jacking operations. Use pipe sections that have a watertight joint.

B. When using steel pipe, ensure that pipe sections have suitable corrosion protection measures.

2.3 SOIL CEMENT

A. Cement treated fill, Section 31 05 15 “Cement Treated Fill.”

B. Grout: Portland cement type, Section 03 61 00 “Cementitious Grouting.”

2.4 Grouting Material:

A. Non-shrink grout for sealing annular spaces.

2.5 PIPE SEALING

A. Provide materials for sealing joints in accordance with manufacturer's specifications.

PART 3 - EXECUTION

3.1 PREPARATION

A. Locate and preserve utilities, Section 31 23 16 “Excavation.”

B. Inspect the site and verify that conditions are suitable for trenchless installation.

C. Identify any geotechnical considerations or potential environmental impacts before commencing work. Do not proceed with installation until unsatisfactory conditions are corrected.

D. Prepare entry and exit pits as required for the selected trenchless method.

E. Ensure that drilling fluids, if used, are properly mixed and maintained.

3.2 JACKING PROCEDURE

A. When casing is to be jacked through a plastic clay, continue uninterrupted operations until casing has been jacked between specified limits.

B. Equip leading section of casing with a jacking head securely attached to prevent any wobble or variation in alignment during jacking operation.

C. Protect driving end against spalling or other damage, and install sufficient bearing shims to intermediate joints to properly distribute jacking stresses. Remove and replace any section showing signs of failure.

D. No excavation in excess of outer dimensions of conduit being jacked will be allowed unless approved. Avoid any loss of earth outside jacking head.

E. Upon completion of jacking operations, pressure grout voids around outside face of the conduit. Grouting around jacked conduit must be started immediately after jacking operations have finished.

F. During the jacking operation, backpack with soil cement any annular space occurring outside of conduit that could affect any surface structure or facility.

G. Ensure minimal disruption to traffic and public, and implement necessary safety measures.

H. Maintain accurate records of the jacking operation including jacking forces, rate of progress, etc.

3.3 PILOT TUNNEL

A. Construct tunnel where casing 60 inches or greater inside diameter is to be jacked for a distance greater than 32 feet.

B. Remove supports for tunnels as jacking progresses.

3.4 PIPE SUPPORT IN CASING TUNNEL

A. Unless indicated otherwise, use redwood skids throughout the length of the pipe tied at every pipe diameter length to brace pipe installed in casing to prevent shifting or flotation during backfilling of annular ring between the casing and carrier pipe.

B. Backfill annular ring with Portland cement grout, Section 03 61 00 “Cementitious Grouting” unless indicated otherwise.

C. Install pipe barrels to rest upon support blocks with the pipe bells clearing the casing invert by at least 1/2 inch.

D. Whenever clay pipe is installed in a casing, use mechanical compression joints.

3.5 BACKFILLING AND SURFACE RESTORATION

A. Backfill and compact any excavations in accordance with local regulations.

B. Restore the surface to its original condition or better, including landscaping, paving, etc. The restoration shall be approved by the OWNER.

3.6 INSPECTION AND TESTING

A. Conduct inspections and testing of the installed utilities to ensure they are functioning properly and there are no leaks.

B. Inspect all joints and fittings for proper installation and integrity.

C. Any necessary repair or rectification work due to faulty installation shall be borne by the CONTRACTOR at no additional cost to the OWNER.

D. Conduct a final inspection with the Architect/Engineer to ensure compliance with specifications and project requirements.

3.7 DOCUMENTATION

A. Submit test reports, inspection reports, records of jacking operation, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the backfilled trenches.

END OF SECTION

SECTION 33 05 25

PAVEMENT RESTORATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section includes the requirements for restoring pavement after utility installations, repairs, or other construction activities.

1.2 RELATED SECTIONS

01 55 26 “Traffic Control”

02 41 14 “Pavement removal”

03 20 00 “Concrete Reinforcing”

03 30 00 “Cast in Place Concrete”

03 30 10 “Concrete Placement”

03 39 00 “Concrete Curing”

03 61 00 “Cementitious grouting”

31 05 15 “Cement Treated Fill”

32 01 13.61 “Slurry Seal”

32 01 13.64 “Chip Seal”

32 01 13.5 “Fog Seal”

32 11 23 “Aggregate Base Course“

32 12 05 “Bituminous concrete”

32 12 13.13 “Tack Coat”

32 13 73 “Concrete Paving Joint Sealants”

32 14 13 “Precast Concrete Unit paving”

32 17 23 “Pavement Markings”

1.3 REFERENCES

A. APWA (Utah) Standards:

1. Plan 255 Bituminous pavement T-patch.

2. Plan 256 Concrete pavement patch.

B. ACI Standards:

1. Hot Weather Concreting.

2. Cold Weather Concreting.

C. ASTM Standards:

1. A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

2. C928 Packaged, Dry, Rapid- Hardening Cementitious Materials for Concrete Repairs.

3. C1315 Liquid Membrane Forming Compounds Having Special Properties for Curing and Sealing Concrete.

4. D4 Bitumen Content.

5. DS Penetration of Bituminous Materials.

6. D92 Flash and Fire Points by Cleveland Open Cup.

7. D95 Water in Petroleum products and Bituminous Materials by Distillation.

8. D113 Ductility of Bituminous Materials.

9. D402 Distillation of Cut-Back Asphaltic (Bituminous) Products.

10. D1664 Coating and Stripping of Bitumen-Aggregate Mixtures.

11. D2041 Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures.

12. D2l70 Kinematic Viscosity of Asphalts (Bitumens).

13. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

14. D6927 - Standard Test Method for Marshall Stability and Flow of Asphalt Mixtures.

15. C150 - Standard Specification for Portland Cement.

16. D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.

17. D3628 - Standard Practice for Selection and Use of Emulsified Asphalts.

1.4 SUBMITTALS

A. Traffic control plan, Section 01 55 26 “Traffic Control.”

B. Product Data: Manufacturer's technical data for asphalt, concrete, and other paving materials.

C. Shop Drawings: Detailed drawings showing the layout, dimensions, and methods for pavement restoration.

D. Test Reports: Certified test reports demonstrating compliance with specified standards.

E. Manufacturer's Instructions: Detailed instructions for the installation of pavement materials.

F. Target sieve gradation for aggregate base.

G. Bituminous pavement mix design.

H. Portland cement concrete mix design and data sheets for joint filler board, concrete joint sealer, concrete bond breaker, concrete chemical additives, curing agent, and reinforcement.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer must have a minimum of 5 years' experience producing similar products.

B. Installer Qualifications: Installer must have a minimum of 3 years' experience performing pavement restoration work.

C. Pre-Installation Meetings: Conduct a pre-installation meeting to review project requirements, installation procedures, and coordination with other trades.

1.6 ACCEPTANCE

A. Aggregate Base: Compaction.

B. Concrete Base: Strength.

C. Bituminous Pavement:

1. Compaction.

2. Grade and cross slope of pavement surface.

3. Surface distortion.

D. Concrete Pavement:

1. Reinforcement placement and concrete strength.

2. Grade and cross slope of pavement surface.

3. Surface distortion.

1.7 WEATHER

A. Bituminous Pavement Restoration:

1. If air and roadbed temperatures in the shade are less than 40 deg F placement is considered a temporary patch.

2. Remove any temporary patching and provide permanent patch material when temperature exceeds 40 deg F. CONTRACTOR may perform work after cold weather season if authorized in writing by ENGINEER.

B. Portland Cement Concrete Pavement Restoration:

1. Hot weather, ACI 305. Set retarding admixture may be used if allowed in mix design. Discontinue placement if ambient air temperature exceeds 100 deg F. in the shade.

2. Cold weather, ACI 306. Concrete accelerating admixtures may be used if allowed in mix design. Provide weather protection until 90 percent of design compressive strength. When removing heat, limit temperature change next to concrete surface to 20 deg F. per 12 hours until the concrete surface temperature reaches ambient.

a. Use of admixtures or curing agent will not relax cold weather placement and cure requirements.

b. Do not use chemical additives to prevent freezing.

c. Prevent loss of moisture during protection.

1.8 SITE CONDITIONS

A. Take note of any existing surface and subsurface conditions that may affect pavement restoration activities.

B. Take into account the condition of adjacent properties and structures and avoid causing any damage during the restoration process.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aggregate Base: Untreated base course material, Section 32 11 23 “Aggregate Base Courses.”

B. Flowable Fill Base: Section 31 05 15 “Cement Treated Fill.”

C. Portland Cement Concrete Base Course: Class 4000, Section 03 30 00 “Cast in Place Concrete.”

D. Tack Coat: Grade SS-1, Section 32 12 13.13 “Tack Coat.”

E. Permanent Marking: Tape or paint, Section 32 17 23 “Pavement Markings.”

2.2 BITUMINOUS PAVEMENT

A. Permanent Warm Weather Bituminous Concrete: PG64-22, DM- l/2, 50 blow, Section 32 12 05 unless indicated elsewhere.

B. Temporary Cold Weather Bituminous Concrete Patching Material: Type MC250, DM-1/2, 50 blow, Section 32 12 05 with hydrated lime or anti- strip agent as indicated in the mix design.

C. Pavement Sealing:

1. Slurry Seal: SS Type II - RS-1, Section 32 01 13.61 “Slurry Seal.”

2. Chip Seal: MC-250. CS-A, Section 32 01 13.64 “Chip Seal.”

3. Fog Seal: Section 32 01 13.50 “Fog Seal.”

D. High Friction Surface Treatment: If required by the specific conditions of the restoration project.

2.3 CONCRETE PAVEMENT

A. Chairs, Bolsters, Bar Supports, Spacers: Section 03 20 00 “Concrete Reinforcing.”

B. Bond Breaker: Paraffin wax, lithium grease, or other semi-solid, inert lubricant.

C. Fillers and Sealer: Section 32 13 73 “Concrete Paving Joint Sealants”:

1. Expansion joint filler, F1 sheet 1/2 inch thick.

2. Contraction joint filler, closed cell Type 1 round backer rod.

3. Contraction joint sealer, HAS1 or HAS4 hot applied.

D. Adhesive Grout: Epoxy gel type II; Section 03 61 00 “Cementitious Grouting.”

E. Reinforcement: Grade 60 ksi galvanized or epoxy coated steel, ASTM A615:

1. Dowel Bar: Smooth.

2. Tie Bar: Deformed.

3. Mat: Deformed.

F. Normal Set Concrete: Class 4000, Section 03 30 00 “Cast in Place Concrete.” Slump range per mix design.

G. High Early Strength Concrete: Quick set.

1. Slump range per mix design, Section 03 30 00 “Cast in Place Concrete”:

2. Concrete compressive strength of 3,000 psi minimum in four (4) hours.

3. Cementitious Material: Rapid hardening or very rapid hardening, ASTM C928.

4. Cement content of mix, per cement manufacturer's recommendations or approved mix design.

5. Non-reactive aggregates in applications subjected to wetting, extended exposure to humid atmosphere, or contact with moist ground.

H. Curing and Sealing Compound: Membrane type, ASTM C1315:

1. Type II Class A or B (white pigmented) for roadway pavement.

2. Clear with red fugitive dye for concrete flat work.

I. Additional reinforcement or specialized materials for concrete pavement subject to heavy loads or challenging environmental conditions.

PART 3 - EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Paver: Use bituminous concrete lay-down machine for final lift if surface restoration is over a trench in the direction of traffic flow or if trench is a wide surface excavation.

3.2 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.”

B. At site, post name, address and telephone number of CONTRACTOR to contact in emergencies.

C. Notify ENGINEER within 24 hours of commencing work of this Section but not less than four (4) hours.

D. Cutting Pavements: Cut full depth and straight, Section 02 41 14 “Pavement Removal.” Remove all bonding inhibitors.

3.3 AGGREGATE BASE

A. Match depth of existing aggregate base or at least eight (8) inches thick.

B. Place lifts not exceeding eight (8) inches before compaction. Compact each lift to 95 percent or greater relative to a modified proctor density.

3.4 CONCRETE SUBSTRATE

A. Match existing substrate thickness.

B. Apply concrete bonding compound, Section 03 30 10 “Concrete Placement”, to edge of existing concrete.

C. Place concrete, Section 03 30 10 “Concrete Placement.”

3.5 BITUMINOUS PAVEMENT RESTORATION

A. APWA Plan 255.

B. Match existing pavement thickness plus 1 inch, but not less than four (4) inches. Maximum thickness is six (6) inches in residential areas and eight (8) inches in non-residential areas.

C. Clean all vertical surfaces that butt against new patchwork. Provide full coverage spray tack coat. Do not spray tack coat on surfaces exposed to public view. Do not apply tack coat by brush.

D. Place bituminous pavement in lifts not less than three (3) inches after compaction. Compact to 94 percent of ASTM D2041 (Rice density) plus or minus two (2) percent.

E. Match adjacent surface slopes.

F. Use lay-down machine for final lift if trench is in direction of traffic.

3.6 CONCRETE PAVEMENT RESTORATION

A. Full Depth Restoration:

1. APWA Plan 256.

2. In vertical load bearing joints, clean vertical surfaces and install tie- bars or dowels. Apply concrete bonding compound, Section 03 30 10 “Concrete Placement.”

3. Place concrete. Prevent segregation.

4. Match adjacent surface slopes. Match adjacent surface texture.

5. Saw cut contraction joints.

B. Partial Depth Restoration:

1. Chip, hydro-blast or saw cut concrete at least one (1) inch deep.

2. Make surfaces free of frost, ice, mud, water, grease, dirt and other materials that hamper bonding.

3. Install bonding agent per manufacturer’s recommendations.

4. Place concrete. Prevent segregation.

5. Match adjacent surface slopes. Make surface texture match existing.

6. After placement, conduct necessary surface finishing to restore the aesthetic and functional aspects of the concrete surface.

C. Cure:

1. Apply membrane forming compound immediately after placement to protect work from hot or cold weather. Apply total coverage in two (2) directions after texturing. Provide ASTM C1315 and Section 03 39 00 “Concrete Curing.”

2. Eliminate thermal shock of concrete by keeping cure temperature even throughout extent and depth of concrete patch.

3. ASTM C1315 should be used for the membrane-forming compound. The curing process should also comply with the guidelines of the National Ready Mixed Concrete Association (NRMCA).

D. Traffic: Not allowed on the repaired area until concrete strength is achieved.

3.7 CONCRETE PAVERS

A. Screed bedding with a notched and cambered screed board to achieve a crown between existing pavers. Use graded aggregate, geotextile, and bedding sand, Section 32 14 13 “Precast Concrete Unit Paving.”

B. After placement, use a plate-type vibrating compactor to compact pavers.

C. Size compactor to provide at least 5,000 lbf force. Sweep joint sand into the joints and vibrate until joints are full. Remove excess joint sand.

D. Match adjacent surface grades with no more than 1/4 inch vertical deviation in 10 feet.

E. Perform a final inspection to ensure the alignment and integrity of the pavers. Replace any cracked or damaged pavers.

3.8 TOLERANCE

A. 1/4 inch vertical deviation from design elevation in 10 feet.

B. Match adjacent surface slopes.

3.9 PAVEMENT MARKINGS

A. Unless indicated otherwise, repair all damaged Pavement markings with matching material types and installation.

3.10 FIELD QUALITY CONTROL

A. Perform compaction tests on subbase, base, and asphalt layers to confirm compliance with specified densities.

B. Inspect the finished pavement for smoothness, texture, and proper alignment.

C. Correct any deficiencies identified during inspection and testing.

D. Conduct a final inspection with the Architect/Engineer to ensure compliance with specifications and project requirements.

3.11 REPAIR

A. Remove bumps and depressions exceeding 1/4 inch vertical deviation in 10 feet.

B. Bituminous Pavement: Repair options include mill and inlay or grinding. Feather edges on bituminous concrete repairs are not allowed. Apply a cationic or anionic tack emulsion to make milled surfaces water resistant.

C. Concrete Pavement: Repair options include grinding, or slab replacement. Apply a water repelling product over surfaces that are ground to make the surfaces water resistant. Repair or replace any slab that cracks, shrinks, or otherwise fails. Do not allow traffic on repaired area until concrete strength is achieved.

D. Upon completion of repair work, carry out an inspection to validate the success of the repair and its compatibility with the surrounding pavement. Document any discrepancies for further remediation.

3.12 CLEANING

A. Remove excess material and debris from the site.

B. Restore the surface to match the surrounding area, including final grading and seeding as required.

3.13 PROTECTION

A. Protect restored pavement from traffic and construction activities until it has reached sufficient strength.

3.14 DOCUMENTATION

A. Submit test reports, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the restored pavement.

END OF SECTION

SECTION 33 08 00

COMMISSIONING OF WATER UTILITIES

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Tests to be performed for commissioning pressurized and non- pressurized water piping systems.

B. Warning: DO NOT use hydrostatic pressures for air-pressure testing.

1.2 REFERENCES

A. ASTM Standards.

1. C497 Testing Concrete Pipe, Sections, or Tile.

2. C969 Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.

3. C1103 Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.

4. C1214 Test Method for Concrete Pipe Sewerlines by Negative Air Pressure (Vacuum).

5. F1417 Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.

6. F2497 Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High Density Polyethylene Pipelines.

B. NASSCO Standards.

1. PACP Pipe Condition Assessment Using CCTV.

1.3 SUBMITTALS

A. Commissioning Plan: Detailed plan outlining commissioning activities, schedule, and responsibilities.

B. CCTV Report: Include the following.

1. CCTV personnel are NASSCO PACP certified.

2. NASSCO PACP certified database and electronic worksheets accompany all progress inspection work.

3. All ENGINEER and NASSCO PACP required header information must be fully and accurately entered on all CCTV reports.

4. Corrections to punch list items are submitted in report form prior to final payment.

C. Commissioning Test Report: Use the commissioning test schedule (Table 3 this section) which identifies tests to be performed for commissioning potable and non-potable water piping systems. For each test performed, submit the following information as applicable.

1. Type of test.
2. Project number and date of the report.
3. Size, type, location and length of pipe in test section.
4. Test pressure and time.
5. Written and still image documentation of locations where deflection deviations, joint gaps, pipe damage, and any other deficiencies are observed.
6. Statement of whether mandrel was or was not able to pass.
7. Amount of leakage versus allowable.
8. Date of test approval.
9. Signature of test supervisor.
10. Signature of Resident Project Representative witnessing the test.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DEFINITIONS

A. CCTV: Acronym for closed-circuit television.

B. Leakage: The quantity of water required to maintain specified hydrostatic test pressure after pipeline has been filled with water and air expelled.

C. Non-rigid Pipe: Any pipe that requires bedding and pipe zone backfill material for structural support to prevent distortion that may be caused by additional backfill placement.

D. PACP: Acronym for Pipeline assessment certification Program. This program is provided by the National Association of Sewer Service Companies (NASSCO).

1.7 PROJECT CONDITIONS

A. CCTV: Run water through subject test system prior to video inspection. Conduct inspection prior to installation of paved surfaces. ENGINEER to be present during video inspection.

1. Record vertical and horizontal deviations, joint gaps, cracks, and pipe damage.

2. Video the entire circumference at each joint. Zoom where necessary.

3. Video image must be clear, continuously illuminated, focused, free from roll, static, or other image distortion qualities.

4. Identify the date, pipe reach, slope, upstream and downstream manhole numbers, and manhole to manhole footage.

5. Provide video inspection log as a computerized data report with a map of the system inspected with appropriate identification labels and still images of defects discovered in the video.

6. Repeat unsatisfactory inspections at no additional cost to OWNER.

B. Manual inspections are to be done by ENGINEER.

1.8 WARRANTY

A. At the end of the one year correction period repeat any test requested by ENGINEER to verify warranty of pipeline performance.

B. OWNER will pay for the cost of additional test inspections if pipe tests meet criteria in this section.

PART 2 – PRODUCTS

2.1 TESTING MATERIALS

A. Testing Equipment: Pressure gauges, flow meters, disinfecting agents, and other equipment necessary for testing and commissioning water utilities.

B. Temporary Facilities: Pumps, hoses, and other temporary facilities required for flushing, testing, and disinfecting water systems.

C. Medium: Water, air.

PART 3 – EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Leakage Recording Equipment:

1. Supply all equipment and power to perform leakage testing.

2. Secure approval of pressure and vacuum gages.

3. Locate all gages and recording equipment away from affect of sunshine or unsuitable weather conditions.

4. Place, vents, taps and drains for the test. Repair pipeline at completion of test at no additional cost to OWNER.

B. CCTV:

1. Video operator is currently NASSCO PACP certified.

2. Camera is to be crawler mounted meeting the following.

a. Head is in the pipe diameter center with lighting sufficient to produce a clear picture of the entire periphery of the pipe.

b. Pan and tilt to a 90 degree angle with the axis of the pipe.

c. Rotate 360 degrees.

d. Crawl at a speed no greater than 30 feet per minute.

3. For pipe lateral replacements constructed by bursting, operate video camera in presence of Project Representative.

C. Mandrel:

1. Diameter whether it is fixed or variable size must be verified with a proving ring or other method according to manufacturer's guideline.

2. Contains at least nine equally spaced runners.

3. Length not less than the diameter.

4. Pulled (not pushed) through pipe.

5. Recommend an alternate method of measurement if mandrel testing would cause damage to internal pipe coating.

3.2 PREPARATION

A. Notify ENGINEER 48 hours in advance of test.

B. Carry out selected tests as pipeline construction progresses to ensure construction methods are producing satisfactory results.

C. Remove debris, sediment and other material from installed pipe before testing. Do not discharge or flush sand, gravel, concrete, debris or other foreign material into any existing pipeline system. Flushing with clean water only will be allowed but with minimal flows to eliminate exceeding capacities of receiving systems. Flushing into existing pressurized water systems is NOT ALLOWED.

3.3 GRADE AND ALIGNMENT TEST

A. Tolerances for pipe placement are as follows.

Table 1 – Grade and Alignment		
Design Grade	Tolerances	
	Grade “’	Alignment
Greater than 1%	1/2 inch in 10 feet	1” from true line
0.5 to 1%	1/4 inch in 10 feet	1” from true line
Less than 0.5%	1/4 inch in 100 feet	1” from true line
NOTES A. Grade does not result in a level or reverse sloping invert. Standing water is evidence of non-compliance. B. For culverts, increase tolerances by 50 percent.		

3.4 JOINT TESTS

A. Gap: Evaluate each pipe joint with a gap exceeding allowance in the following table. Recommend appropriate corrective action according to manufacturer's recommendations.

Table 2 – Joint Gap	
Pipe Diameter, inches	**Allowance, maximum**
Less than 12	A.
12 – 36	0.75 inch
42 – 48	1.00 inch
54 – 90	1.25 inches
96 -144	1.75 inches
NOTES A. In pipes less than 12 inches diameter, allowable separation is equal to or less than amount permitted by manufacturer.	

B. Invert Elevation: Variation in invert elevation where pipe sections join shall not exceed 1/64 inch per inch of pipe diameter, or 1/4 inch maximum.

3.5 INFILTRATION TEST

A. Tolerance: 200 gallons per inch, per mile, per day maximum (EPA's standard for sanitary sewers is specified). If ground water table is less than two (2) feet above the crown of the pipe the infiltration test is not required.

B. Concrete Pipe: ASTM C969.

C. Plastic Pipe: ASTM F2497.

3.6 EXFILTRATION TEST

A. Preparation: Air test or hydrostatic test is CONTRACTOR's choice.

B. Air Test:

1. Plastic Pipe: ASTM F1417.

a. For pipe up to 30 inches diameter, pressure drop is 0.5 psi.

b. For pipe larger than 30 inches diameter, isolated joint test is 3.5 psi. Maximum pressure drop is 1.0 psi in 5 seconds.

2. Concrete Pipe:

a. ASTM C1214 for concrete pipe 4" to 24" diameter.

b. ASTM C1103 for concrete pipe 27" and larger.

C. Hydrostatic Test: Provide air release taps at pipeline's highest elevations and expel all air before the test. Insert permanent plugs after test has been completed.

1. Plastic Pipe: ASTM F2497.

2. Concrete Pipe: ASTM C497. Abide by Section 3 and Section 16 in the ASTM standard and applicable recommendations of manufacturer.

D. Locate and repair leakage and retest until leakage rate is less than allowable.

E. Repair any noticeable leakage even if total leakage is less than allowable.

3.7 DISTORTION TEST

A. Concrete Pipe: Maximum crack width is 0.1 inch. Provide photographs of all cracks for possible mitigation or monitoring purposes.

1. Record location of cracks smaller than 0.1 inch. ENGINEER will evaluate crack at end of one year correction period.

2. For cracks exceeding 0.01 inch, measure crack width and provide photographs for monitoring purposes during subsequent inspections.

B. Plastic and Other Pipe: Maximum internal diameter reduction in any plane measured full length of installation prior to pavement placement, and at the end of the correction period is as follows.

1. Polyvinyl chloride pipe, 7.5 percent.

2. High density polyethylene pipe, 5 percent.

3. Polypropylene pipe, 5 percent.

4. Ductile iron pipe, 3 percent.

5. Corrugated metal pipe, 7.5 percent.

3.8 OBSTRUCTION TEST

A. Maximum protuberance is 1 inch.

3.9 TRACER WIRE CONTINUITY TEST

A. Test all tracer wire sections for continuity.

3.10 COMMISSIONING TEST SCHEDULE

A. The following table identifies required commissioning tests.

Table 3 - Commissioning Test Schedule

		Alignment	Grade	Joint	Infiltration	Exfiltration	Distortion	Obstruction	Disinfection	Tracer Wire
Gravity Irrigation Landscaping	A.		•							
Pressure Irrigation Landscaping	A,B,C.		•			•				
Sanitary Sewers	B,C.	•	•	•	•	•	•	•		
Sub-drains										
Storm Drains	C,D.	•	•	•	•	•	•	•		
Potable Water	C,D,E.									
Non-potable water	D.						•	•		•

NOTES

A. All lateral pipes drain.

B. Operational testing: Landscaping systems.

- Perform operational testing after hydrostatic test is complete, backfill is in place, and sprinkler heads are adjusted to final coverage.
- Demonstrate system meets coverage requirements and automatic controls function properly.
- Coverage requirements are based on operation of one (1) circuit at a time.

C. Exfiltration test for pressure pipeline systems.

D. Exfiltration when requested by ENGINEER or specified elsewhere.

E. Legally dispose disinfection and flushing water and ensure no damage to the environment.

3.11 FIELD QUALITY CONTROL

A. Perform inspections and tests to ensure compliance with commissioning requirements and project specifications.

B. Document all test results and commissioning activities.

C. Address any deficiencies identified during testing and commissioning.

3.12 REPAIR

A. Repair pipeline system at no additional cost to OWNER until it passes commissioning tests.

3.13 CLEANING

A. Remove excess material and debris from the site.

B. Ensure that the water system is clean and ready for use.

3.14 DOCUMENTATION

A. Submit test reports, commissioning records, and O&M manuals.

B. Provide final as-built drawings showing the location and details of the commissioned water utility systems.

END OF SECTION

SECTION 33 12 16

WATER VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gate, butterfly, plug, check, pressure reducing, pressure relief, control valves and their installation.

2. All necessary materials, labor, and equipment for the installation of water valves.

3. All necessary coordination with the utility company and local authorities for the installation work.

1.2 RELATED SECTIONS

05 05 23 “Metal Fastenings”

1.3 REFERENCES

A. American Society of Testing and Materials (ASTM) Standards:

1. F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

B. American Water Works Association (AWWA) Standards:

1. C111 Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.

2. C500 - Metal-Seated Gate Valves for Water Supply Service.

3. C504 Rubber-Seated Butterfly Valves.

4. C507 - Ball Valves, 6 In. Through 48 In. (150 mm Through 1200 mm).

5. C508 Swing-Check Valves for Waterworks Service, 2 In. through 24 In. NPS.

6. C509 Resilient-Seated Gate Valves for Water and Sewerage Systems.

7. C512 - Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.

8. C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.

9. C550 Protective Interior Coatings for Valves and Hydrants.

10. C600 Installation of Ductile—Iron Water Mains and Their Appurtenances.

C. Manufacturers Standardization Society (MSS):

1. SP-67 – Butterfly Valves

D. Local Building Code and State Regulations:

1. Adhere to local building codes and state regulations regarding the installation of water valves.

1.4 SUBMITTALS

A. Product Data: Manufacturer's technical data for water valves, including dimensions, materials, and performance characteristics. As a minimum include dimensions, weights, materials lists and operation charts.

B. Shop Drawings: Detailed drawings showing the layout, dimensions, and installation methods for water valves.

C. Test Reports: Certified test reports demonstrating compliance with specified standards.

D. Manufacturer's Instructions: Detailed instructions for the installation, operation, and maintenance of water valves.

E. Provide a detailed work schedule for the installation process and submit it to the ENGINEER and the utility company for approval.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer must have a minimum of 5 years' experience producing similar products and be certified to relevant standards.

B. Installer Qualifications: Installer must have a minimum of 3 years' experience performing similar work.

C. Pre-Installation Meetings: Conduct a pre-installation meeting to review project requirements, installation procedures, and coordination with other trades.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 - PRODUCTS

2.1 VALVES – GENERAL

A. Underground:

1. Less than three (3) inches: Screwed ends.

2. 3 inches and larger: Flanged or mechanical joint ends. Non-rising stem. Two inches square operating nut. Low alloy steel bolts, AWWA C111.

B. Submerged or Above Sewage or Water:

1. Valve body bolts per manufacturer's recommendations.

2. For joining valve to piping system use stainless steel nuts and bolts, Section 05 05 23 "Metal Fastenings."

C. Below an Operating Deck: Provide shaft extension from the valve to deck level.

D. Above Ground: Non-rising stems equipped with a hand wheel.

E. Manually Operated Valves Over six (6) feet Above Operating Level: Provide chain operated handles.

F. Clearance: Install so handles clear all obstruction when moved from open to closed.

G. Rated Working Pressure: 150 psi if not indicated.

H. Coating: Interior, AWWA C550. Exterior per manufacturer's recommendation.

I. All valves should be tested by the manufacturer before shipment to ensure they are leak-free and in proper working condition.

2.2 GATE VALVES

A. Metal-Seated Gate Valves: Conforming to AWWA C500.

B. Resilient-Seated Gate Valves: Conforming to AWWA C509 and AWWA C515.

C. 3 inches through 48 inches, cast iron body, bronze mounted, non-rising stem with "O" ring seals.

D. Open counterclockwise.

E. The gate valve should have a back seat feature to facilitate repacking of the stuffing box while the valve is fully open and the pipeline is under pressure.

2.3 BUTTERFLY VALVES

A. Rubber-Seated Butterfly Valves: Conforming to AWWA C504 and MSS SP-67.

B. 3 inches through 48 inches, cast iron body, bronze mounted.

C. Short body if disc will not interfere with adjacent fittings or long body at CONTRACTOR's option.

D. Wafer Valves: Subject to ENGINEER's approval.

E. The butterfly valve should be capable of being locked in the open or closed position.

2.4 ECCENTRIC PLUG VALVES

A. Material: Cast iron body, bronze mounted, non-lubricated, eccentric, quarter-turn type with resilient face plugs, ductile iron discs with upper and lower shafts integral.

B. Markings: Indicate open and close position.

C. Port Areas: At least 82 percent of full pipe area.

D. Resilient Seat Seals: Buna N, field replaceable.

E. The plug valve should be designed for easy and quick maintenance without the need for special tools.

2.5 CHECK VALVES

A. Conforming to AWWA C508.

B. Less than three (3) inches: Y-pattern, bronze, regrinding, swing check valve, 200 psi working pressure.

C. 3 inches and larger: Iron body, bronze mounted, swing valves with stainless steel hinge pins and outside weight and lever if not indicated otherwise.

D. Check valves should prevent backflow and water hammer.

2.6 PRESSURE REDUCING VALVES - SERVICE LINE

A. Operation: Capable of reducing a varying higher upstream pressure to an adjustable constant lower downstream pressure.

B. Spring and nylon reinforced diaphragm type construction.

C. Equip with Y-strainer upstream of valve.

D. The valve should have a strainer to protect it from debris in the pipeline.

2.7 PRESSURE REDUCING VALVES - MAIN LINE

A. Operation: Capable of maintaining an adjustable constant downstream pressure regardless of upstream pressure.

B. Type: Hydraulically operated using a direct-acting, spring-loaded, normally open, pilot valve controlled diaphragm:

1. Single removable seat and a resilient disc. No "O" ring type discs permitted. No external packing glands permitted. No pistons operating main valve or pilot controls permitted.

2. Y-strainers on pilot controls, variable closing and opening speed controls and a valve position indicator.

C. Rating: 250 psi working pressure.

D. Connection: Flanged.

E. Pressure Gage: Upstream and downstream of valve capable of accurately measuring system pressures.

F. The valve should have an isolating feature to allow for maintenance without interrupting the flow.

2.8 PRESSURE RELIEF VALVES

A. Operation: Maintain a constant upstream pressure by passing or relieving excess pressure.

B. Closed Valves: Drip-tight.

C. Type: Hydraulically operated, pilot control using a diaphragm with a single removable seat and resilient disc.

D. Pilot Controls: Direct acting, adjustable between 20 and 200 psi, spring- loaded diaphragm valve.

E. Rating: 250 psi working pressure.

F. Connection: Flanged.

G. The valve should have an isolating feature to allow for maintenance without interrupting the flow.

2.9 CONTROL VALVE

A. Globe: Diaphragm actuated, single seated, composition disc, hydraulically operated.

B. Pilot Controls: Externally mounted, four-way, solenoid pilot valve with self-cleaning strainers and diaphragm type check valves:

1. Equipped with a limit switch for pump control.

2. Equipped with a built-in lift check valve to prevent flow reversal.

C. Rating: 250 psi working pressure.

D. Connection: Flanged.

E. Solenoids and Limit Switch: Supplied with operating voltage indicated.

F. The control valve should have an isolating feature to allow for maintenance without interrupting the flow.

2.10 BALL VALVES

A. Ball Valves: Conforming to AWWA C507.

2.11 AIR VALVES

A. Air Release Valves: Conforming to AWWA C512.

B. Air/Vacuum Valves: Conforming to AWWA C512.

C. Combination Air Valves: Conforming to AWWA C512.

2.12 ACCESSORIES

A. Mechanical Couplings: Conforming to ASTM F1476.

B. Extension Stems: As required to operate valves from the surface.

C. Valve Boxes: Cast iron or plastic valve boxes suitable for the specified valve size and installation conditions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect the site and verify that conditions are suitable for the installation of water valves. Do not proceed with installation until unsatisfactory conditions are corrected.

B. Prepare a detailed installation plan outlining the scope, schedule, and procedures for installing water valves.

3.2 INSTALLATION

A. Flush all lines before valve installation.

B. In ductile iron water mains, AWWA C600.

C. Install butterfly valve shafts vertical in vault boxes and horizontal otherwise.

D. After installation, all valves should be inspected for leaks and proper operation.

E. Ensure proper clearance around valves for safe and easy operation.

F. Record the location of all underground valves on as-built drawings for future reference.

G. Valve orientation should be consistent throughout the system to avoid confusion during operation.

3.3 FIELD QUALITY CONTROL

A. Perform pressure testing of installed pipes to ensure no leaks.

B. Inspect all joints for proper installation and integrity.

C. Correct any deficiencies identified during inspection and testing.

D. Document all test results and installation activities.

E. Conduct a final inspection with the owner to ensure compliance with specifications and project requirements.

3.4 CLEANING

A. Remove excess material and debris from the site.

B. Clean the surface of valves to remove dirt, stains, and other contaminants.

3.5 PROTECTION

A. Protect installed valves from damage during the remainder of construction activities.

3.6 DOCUMENTATION

A. Submit test reports, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed piping system.

END OF SECTION

SECTION 33 12 19

HYDRANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dry-barrel fire hydrants, valves, piping, and accessories.

1.2 RELATED SECTIONS

03 30 00 “Cast in Place Concrete”

05 05 23 “Metal Fastenings”

31 23 16 “Excavation”

31 23 23 “Backfilling for Structures”

32 05 10 “Backfilling Roadways”

32 11 23 “Aggregate Base Courses”

32 91 19 “Landscape Grading”

33 05 05 “Ductile Iron Pipe”

33 05 07 “Polyvinyl Pipe”

33 05 09 “Steel Pipe”

33 05 20 “Backfilling Trenches”

33 08 00 “Commissioning of Water Utilities”

33 12 19 “Hydrants”

33 13 00 “Disinfectant”

1.3 REFERENCES

A. APWA (Utah) Standards:

1. Plan 511 Fire hydrant with valve.
2. Plan 561 Direct bearing thrust block.
3. Plan 562 Tie-down thrust restraints.

B. AWWA Standards:

1. C110 Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids.
2. C111 Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
3. C209 Cold-Applied Tape Coatings for the Exterior of Special Section, Connections, and Fittings for Steel Water Pipelines.
4. C210 Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
5. C213 Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel water Pipelines.
6. C214 Tape Coating Systems for the Exterior of Steel Water Pipelines.
7. C502 Dry-Barrel Fire Hydrants.
8. M17 Manual for Installation, Operation, and Maintenance of Fire Hydrants.

1.4 SUBMITTALS

A. Product Data: Manufacturer's technical product data and installation instructions.

B. Shop Drawings: Show interface and spatial relationship between piping and adjacent structures.

C. Field Quality Control Reports: For system commissioning, Section 33 08 00.

D. Manufacturer’s Instructions: Detailed instructions for the installation, operation, and maintenance of hydrants.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer must have a minimum of 5 years’ experience producing similar products and be certified to relevant standards.

B. Installer Qualifications: Installer must have a minimum of 3 years’ experience performing similar work.

C. Pre-Installation Meetings: Conduct a pre-installation meeting to review project requirements, installation procedures, and coordination with other trades.

1.6 PRODUCT HANDLING

A. Package fire hydrants, gate valves, and valve boxes for protection against dirt and damage during shipment and storage.

B. Do not plug drain hole.

1.7 JOB CONDITIONS

A. Notify appropriate fire department as soon as hydrant is removed or placed in service.

B. Existing utilities: Verify the location of existing utilities before beginning work to prevent accidental damage.

PART 2 - PRODUCTS

2.1 DRY-BARREL FIRE HYDRANT

A. AWWA C502.

B. Hydrant colors should conform to local jurisdictional or NFPA guidelines for hydrant color coding based on flow rates.

C. Cast iron compression type, opening against pressure and closing with pressure, base valve design, 150 psi working pressure, with 1/4 inch diameter minimum tapping and bronze plug in standpipe:

1. Size: 5-1/4 inch valve opening.

2. Direction to Open Hydrant: Counterclockwise.

3. Size and Shape of Operating and Cap Nuts: Pentagon. l- l/2 inch point to flat.

4. Hose Nozzles: Two 2-1/2 inch national standard thread, cap, gasket and chain.

5. Pumper Nozzle: One 4-1/2 inch national standard thread, cap, gasket and chain.

6. Depth of Burial: 48 inches or consistent with main depth.

7. Connection to Main: Six (6) inches flanges or mechanical joint.

8. Pressure: 150 psi working pressure and 300 psi hydrostatic pressure.

9. Inlet Bottom Connection: Six (6) inches mechanical joint or flanged in accordance with AWWA C110 and AWWA C111, designed to allow separation at the sidewalk or ground level when hydrant is sheared off.

10. Automatic Drain: Opens as the hydrant is closed.

2.2 PIPE AND FITTINGS

A. Ductile Iron: Section 33 05 05 “Ductile Iron.” Standard drilling with joints per AWWA C110.

B. PVC: Section 33 05 07 “Polyvinyl Chloride Pipe.”

C. Steel: Section 33 05 09 “Steel Pipe.” Standard drilling, 150 lb.

D. Spool: Schedule 40 steel, epoxy lined, exterior wrapped with minimum six (6) mil thick polyethylene sheet and tape wrap, AWWA C210 or C213 and C209 or C214 with two welded in place 150 lb. steel ANSI B 16.5 slip on flanges.

2.3 VALVES

A. Gate Valve: Section 33 12 19 “Hydrants.”

B. If indicated, furnish an auxiliary six (6) inch diameter valve with end connections as required.

2.4 ACCESSORIES

A. Bolts, Nuts, Washers: Stainless steel, Section 05 05 23 “Metal Fastenings.”

B. Anchorages: Provide anchorages for tees, wyes, crosses, plugs, caps, bends, valves, and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages.

C. Thrust Blocks: Concrete Class 2000 minimum cast-in-place, Section 03 30 00 “Cast in Place Concrete.”

D. Valve Box, Valve Chamber: Section 33 12 19 “Hydrants.”

E. Extension stems: Provide extension stems as necessary for deeper burials to maintain a consistent operating nut elevation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare a detailed installation plan outlining the scope, schedule, and procedures for installing hydrants.

B. Excavation, Section 31 23 16 “Excavation.”

3.2 INSTALLATION

A. Install hydrant according to APWA Plan 511 and AWWA M17.

B. Install hydrants, valves, and valve boxes as indicated and located. Hydrants shall not be connected to or located within 10 feet of a sanitary sewer or storm drain.

C. Install so bottom of hydrant base flange is above grade four (4) inches plus or minus two (2) inches.

D. Point 4-1/2 inch pumper nozzle to face the street.

E. Drain holes at base of hydrant to remain clear with a minimum of 1 cubic yard of clean sewer rock (Section 32 11 23) placed around hydrant base and drain. Place sheet plastic over gravel to prevent silting.

F. Coal tar and tape wrap steel pipe.

G. Grease all buried nuts, bolts, and steel ancillaries then wrap with six (6) mil thick polyethylene sheet and tape wrap.

H. Install thrust blocks according to APWA Plan 561 or 562.

I. Install hydrants at locations designated by the fire department or local code requirements.

J. Where hydrants are installed at the end of a main, install a gate valve and blind flange to allow for future expansion of the system.

3.3 BACKFILLING

A. Secure water company permission to commence backfilling operation.

B. Trenches, Section 33 05 20 “Backfilling Trenches.”

C. Structures, Section 31 23 23 “Backfilling for Structures.”

D. Landscaping, Section 32 91 19 “Landscape Grading.”

E. Pavements, Section 32 05 10 “Backfilling Roadways.”

F. Compaction: Ensure backfill is properly compacted to prevent future settlement.

3.4 PAINT

A. Paint buried portion of hydrant with two coats of coal tar enamel or asphalt.

B. Paint hydrant barrel and caps with one coat primer and final coat per water company paint standards.

3.5 FIELD QUALITY CONTROL

A. Commissioning, Section 33 08 00 “Commissioning of Water Utilities.”

B. Disinfection, Section 33 13 00 “Disinfection.”

C. Hydrostatic testing: Ensure the hydrant, and its associated piping, holds the specified system pressure without leakage for the required duration.

D. Flow testing: Conduct flow testing of each hydrant after installation to verify that it meets minimum flow requirements.

E. Visual inspection: Perform a final visual inspection to verify proper installation and to check for visible leaks or damage.

F. Document all test results and installation activities.

3.6 CLEANING

A. Remove excess material and debris from the site.

B. Clean the surface of hydrants to remove dirt, stains, and other contaminants.

3.7 PROTECTION

A. Protect installed hydrants from damage during the remainder of construction activities.

3.8 DOCUMENTATION

A. Submit test reports, installation records, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed hydrants.

END OF SECTION

SECTION 33 12 33

WATER METER

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water meters, service connections, materials.

1.2 RELATED SECTIONS

33 05 03 “Copper Pipe”

33 05 06 “Polyethylene Pipe”

1.3 REFERENCES

A. AWWA Standards:

1. C704 Cold-Water Meters - Propeller Type for Main Line Applications.

2. C800 Underground Service Line Valves and Fittings.

1.4 SUBMITTALS

A. Equipment material diagram and parts schematic.

B. Product Data: Manufacturer’s technical data for water meters, including dimensions, materials, and performance characteristics. Shall include Manufacturer's test records for range and accuracy of meter being furnished.

C. Shop Drawings: Detailed drawings showing the layout, dimensions, and installation methods for water meters.

D. Test Reports: Certified test reports demonstrating compliance with specified standards.

E. Manufacturer’s Instructions: Detailed instructions for the installation, operation, and maintenance of water meters.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer must have a minimum of 5 years’ experience producing similar products and be certified to relevant standards.

B. Installer Qualifications: Installer must have a minimum of 3 years’ experience performing similar work.

C. Pre-Installation Meetings: Conduct a pre-installation meeting to review project requirements, installation procedures, and coordination with other trades.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 – PRODUCTS

2.1 METERS FOR SYSTEM PIPING

A. Materials and Construction: AWWA C704:

1. Cast iron bodies, 175 psi working pressure, flanged connections.
2. Built-in straightening vanes.
3. Working pressure 150 psi.
4. Polyethylene plastic propeller.
5. Stainless steel shaft with stainless steel ball bearings, lubricated by means of a single pressure fitting.

B. Accuracy: Plus or minus two (2) percent of scale for velocities over 1 foot per second.

C. Totalizer: Six digits reading in units required.

2.2 METERS FOR SERVICE PIPING

A. Provided by OWNER unless indicated otherwise.

2.3 SERVICE LINE, VALVES, AND FITTINGS

A. Water Meter:

1. Service Pipe: Copper, Section 33 05 03 or smooth wall polyethylene, Section 33 05 06. The service pipe between main and meter and to a point not less than 1 foot from the public way side of the property line cannot exceed the meter size.
2. Service Valves and Fittings: AWWA C800.
3. Meter Setters: Brass, with angle fittings, saddle nuts and gaskets.
4. Corporation Stops and Angle Valves: Invert key design.
5. Bypasses: Not allowed on any service installation without approval of ENGINEER.

2.4 METER BOXES

A. Meters to 1" Service: Plastic or asphalt-dipped metal. Fiber meter boxes not acceptable.

B. Meters 1-1/2" and Larger: Reinforced concrete with a minimum clearance of 12" from each side of meter plumbing.

C. Cover: Ductile or cast iron with utility inscription.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install meter box, meter setters, valves, etc. at indicated locations. If not indicated, install in street right-of-way parking strip or at a location approved by ENGINEER.

B. Install meter setters level and horizontal. Provide suitable pipe lengths to prevent stress.

C. DO NOT operate utility agency's main line valves. Contact agency if valves are to be operated. If required by water utility agency notify affected water users.

D. OWNER Supplied Meters: Installed by CONTRACTOR unless indicated otherwise.

3.2 FIELD QUALITY CONTROL

A. Perform inspections and tests to ensure compliance with installation requirements and project specifications.

B. Document all test results and installation activities.

C. Address any deficiencies identified during inspection and testing.

3.3 CLEANING

A. Remove excess material and debris from the site.

B. Clean the surface of meters to remove dirt, stains, and other contaminants.

3.4 PROTECTION

A. Protect installed meters from damage during the remainder of construction activities.

3.5 DOCUMENTATION

A. Submit test reports, installation records, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed meters.

END OF SECTION

SECTION 33 13 00

DISINFECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Disinfection of potable water system.
2. Test and report results.

1.2 RELATED SECTIONS

33 08 00 “Commissioning of Water Utilities”

1.3 REFERENCES

A. AWWA Standards:

1. A100 Water Wells.
2. B300 - Hypochlorites.
3. B301 - Liquid Chlorine.
4. B302 - Ammonium Sulfate.
5. B303 - Sodium Chlorite.
6. C65l - Disinfecting Water Mains.
7. C652 - Disinfection of Water-Storage Facilities.
8. C653 - Disinfection of Water Treatment Plants.
9. C654 - Disinfection of Wells.

B. NSF/ANSI 60 - Drinking Water Treatment Chemicals—Health Effects.

C. State of Utah Standards:

1. Public Drinking Water Regulations, Part 2, Section 12.

1.4 SUBMITTALS

A. Disinfection Plan: Detailed procedures for the disinfection process, including methods, chemicals, concentrations, and contact times.

B. CONTRACTOR’s evidence of experience in disinfection.

C. Bacteriological laboratory's certification.

D. Manufacturer’s Instructions: Detailed instructions for the use of disinfectants and related equipment.

E. Disinfection Report: Three (3) copies containing:

1. Date issued.
2. Project name and location.
3. Treatment contractor's name, address and phone number.
4. Type and form of disinfectant used.
5. Time and date of disinfectant injection started.
6. Time and date of disinfectant injection completed.
7. Test locations.
8. Initial and follow-up disinfectant residuals in ppm for each outlet tested.
9. Time and date of flushing start.
10. Time and date of flushing completion.
11. Disinfectant residual after flushing in ppm for each outlet tested.
12. Flush water disposal location and acceptance by local agency.

F. Bacteriological Report: Three (3) copies including:

1. Date issued.
2. Project name and location.
3. Laboratory's name, certification number, address, and phone number.
4. Time and date of water sample collection.
5. Name of person collecting samples.
6. Test locations.
7. Time and date of laboratory test start.
8. Coliform bacteria test results for each outlet tested.
9. Certification that water conforms or fails to conform to bacterial standards of State of Utah public drinking water regulations.
10. Bacteriologist's signature.

1.5 QUALITY ASSURANCE

A. Bacteriological Laboratory: Certified by State of Utah if laboratory is other than OWNER's laboratory.

B. Pre-Disinfection Meetings: Conduct a pre-disinfection meeting to review project requirements, disinfection procedures, and coordination with other trades.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. Disinfectant Residual: The quantity of disinfectant in treated water.

B. ppm: Parts per million.

1.8 PRODUCT HANDLING

A. Store and protect disinfectant in accordance with manufacturer's recommendations to protect against damage or contamination. Do not use unsuitable disinfectant.

B. Follow all instruction labeling for safe handling and storage of disinfectant materials.

C. Disposal: Handle the disposal of used disinfectant and any other waste materials in accordance with all applicable local, state, and federal regulations.

1.9 REGULATORY REQUIREMENTS

A. Conform to State of Utah public drinking water regulations.

PART 2 - PRODUCTS

2.1 DISINFECTANT

A. AWWA B301. Liquid chlorine 99.5 percent pure by volume.

B. AWWA B300. Sodium hypochlorite not less than 100 grams per liter available chlorine.

C. AWWA B300. Calcium hypochlorite 65 to 70 percent available chlorine by weight in granular form.

D. Powder, tablet, or gas according to manufacturer's specification.

2.2 ALKALI

A. Caustic soda or soda ash.

2.3 ACID

A. Hydrochloric (muriatic).

2.4 TEST KIT

A. Use a test kit for measuring residual chlorine which is in compliance with the Standard Methods for the Examination of Water and Wastewater.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide necessary signs, barricades, and notices to prevent accidental exposure to disinfecting materials, consuming disinfecting water, or disturbing system being disinfected.

B. Make sure potable water system is complete, clean, and that the system to be disinfected is not connected to an existing system.

3.2 DISINFECTION OF WATER LINES

A. Use one method defined under AWWA C651 that is acceptable to ENGINEER.

B. After pressure testing per Section 33 08 00, flush system through hydrants or if a hydrant does not exist, install a tap of sufficient size to provide 2.5 feet per second flushing velocity in the line.

C. Starting at outlet closest to water source, bleed water from each outlet until chlorine residual reaches outlet. Repeat process at each outlet throughout system.

D. Collect a bacteriological water sample at end of line to be tested. If sample fails bacteriological test, flush system and retest. Continue flushing and retesting until a good sample is obtained.

E. If flushing does not produce a passing bacteriological test disperse disinfectant throughout system to obtain 10 to 25 ppm of free chlorine residual.

F. Flush the chlorinated water from the main until chlorine measurements show concentration in the water leaving the main is no higher than that generally prevailing in the system or is acceptable for domestic use.

G. After a passing bacteriological test sample is obtained, let the system relax for 24 hours. Flush and collect a subsequent bacteriological sample for testing. If the subsequent test passes then water line is acceptable.

H. Dead Ends: Pay special attention to dead ends in the water line where disinfection may not be as effective. Extra disinfection methods may be needed at these locations.

3.3 DISINFECTION OF CULINARY WELLS

A. Use one method defined under AWWA A100 that is acceptable to ENGINEER.

B. Do not start disinfection until well is thoroughly cleaned.

C. Use a disinfecting solution containing a minimum of 50 ppm residual chlorine.

D. Flush system after disinfection.

3.4 DISINFECTION OF WATER STORAGE RESERVOIRS

A. Use one method defined under AWWA C652 that is acceptable to ENGINEER.

B. Do not start disinfection until water storage tank is thoroughly cleaned.

C. Provide and use necessary safety equipment for workers in contact with disinfectant or gasses.

D. Flush system after disinfection.

E. Safety: Keep the reservoir out of service until it passes bacteriological testing to avoid potential health hazards.

3.5 FIELD QUALITY CONTROL

A. Bacteriological Test:

1. Collect samples for testing no sooner than 16 hours after system flushing.

2. Analyze water samples per State of Utah requirements.

3. If bacteriological test proves water quality to be unacceptable, repeat system treatment.

4. Do not place water systems into service until a passing bacteriological test is made. Provide a copy of the passing test to ENGINEER.

B. Disposal of Disinfectant:

1. Legally dispose of disinfecting water and ensure no chlorine buildup or damage to the environment.

C. Repeat Sampling: Conduct repeat sampling after a period of normal system use, as directed by ENGINEER, to ensure the continued absence of harmful bacteria.

D. pH Testing: In addition to bacteriological testing, pH testing should be carried out to ensure that the water is not overly acidic or alkaline after disinfection.

3.6 FIELD QUALITY CONTROL

A. Perform inspections and tests to ensure compliance with disinfection requirements and project specifications.

B. Document all test results and disinfection activities.

C. Address any deficiencies identified during inspection and testing.

3.7 CLEANING

A. Remove excess material and debris from the site.

B. Clean the site to remove any residual disinfectant and ensure safety for personnel and the public.

3.8 DOCUMENTATION

A. Submit test reports, disinfection records, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of disinfected systems.

END OF SECTION

SECTION 33 14 00

WATER DISTRIBUTION AND TRANSMISSION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Installation of a pressurized water pipe system.

2. Refer to Section 33 31 00 “Sanitary Sewerage Systems” if the system is a non-pressure sanitary sewer.

3. Refer to Section 33 41 00 “Drainage Systems” if the system is a non-pressure storm drain, sub-drain, irrigation system, etc.

1.2 RELATED SECTIONS

01 78 23 “Field Engineering”

01 78 39 “Project Record Documents”

03 30 00 “Cast in Place Concrete”

03 40 00 “Precast Concrete”

03 61 00 “Cementitious Grouting”

04 05 16 “Masonry Mortar and Grout”

05 05 23 “Metal Fastenings”

31 23 16 “Excavation”

31 23 23 “Backfilling for Structures”

33 05 03 “Copper Pipe”

33 05 20 “Backfilling Trenches”

33 05 25 “Pavement Restoration”

33 08 00 “Commissioning of Water Utilities”

33 12 16 “Water Valves”

33 12 19 “Hydrants”

33 13 00 “Disinfectant”

33 31 00 “Sanitary Sewerage Systems”

33 41 00 “Drainage Systems”

1.3 REFERENCES

A. American Concrete Pipe Association (ACPA) Publications: Concrete Pipe Handbook.

B. APWA (Utah) Standards:

1. Plan 255 Bituminous pavement T-patch.
2. Plan 256 Concrete pavement patch.
3. Plan 381 Trench backfill.
4. Plan 382 Pipe zone backfill.
5. Plan 521 3/4” and 1” meter.
6. Plan 522 1-1/2” and 2” meter.
7. Plan 541 Water service line.
8. Plan 542 Water service line loop.
9. Plan 543 Watermain loop.
10. Plan 551 3/4” and 1” service taps.
11. Plan 552 1-1/2” and 2” service taps.
12. Plan 561 Direct bearing thrust block.
13. Plan 562 Tie-down trust restraints.
14. Plan 574 Cover collar for water valve boxes.

C. AWWA Standards:

1. C600 Installation of Ductile-Iron Water Mains and Their Appurtenances.
2. C605 Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
3. C800 Underground Service Line Valves and Fittings.
4. C901 Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. Through 3 in., for Water Service.
5. M11 Manual for Steel Pipe - Design and Installation.

D. Copper Development Association (CDA) Standards.

E. Applicable water company requirements standards.

1.4 SUBMITTALS

A. Product data: Submit manufacturer's technical product data and installation instructions.

B. Commissioning: Provide Section 33 08 00 "Commissioning of Water Utilities" submittals.

C. Record Documents, Section 01 78 39 "Project Record Documents": Include details of underground structures, connections, thrust blocks and anchors. Show interface and spatial relationship between piping and adjacent structures.

D. Operating and Maintenance: Submit data, Section 01 78 23 "Operation and Maintenance Data." Include maintenance data, parts list, product data and Shop drawings.

E. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

A. Not Applicable.

1.6 ACCEPTANCE

A. Each component in the distribution and transmission system must pass applicable commissioning requirements in Section 33 08 00 "Commissioning of Water Utilities."

1.7 PERFORMANCE REQUIREMENTS

A. Depth of Cover:

1. Minimum as indicated in local building code from top of pipe to ground surface. 72 inches maximum unless ENGINEER authorizes otherwise.

2. If less cover, provide additional protection to withstand frost and external loads.

B. Remove any section of pipe already placed that is found to be defective or damaged. Relay or replace without additional cost to OWNER.

C. The system should withstand the anticipated seismic activity of the region.

1.8 SITE CONDITIONS

A. Minimize neighborhood traffic interruptions. Barricade stockpiles.

B. Secure acceptance of pipeline lateral tie-in work.

C. Repair public and private facilities damaged by CONTRACTOR.

D. Do not operate any currently active water valve until its owner and water company's permission is secured.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, and capacities indicated.

B. Use only NSF approved products in drinking water systems. All such products shall be appropriately stamped with the NSF logo.

C. Where not indicated, provide proper selection as determined by installer and acceptable to ENGINEER to comply with installation requirements.

D. Provide sizes and types of equipment connections for fittings of material that matches pipe material used in the piping system.

E. Where more than one type of material or product Option is indicated, selection is installer's choice.

F. Provide pipe fittings and accessories of same material and weight or class as pipe, with joining method indicated or recommended by manufacturer.

G. Provide pipe marker tapes to allow easy identification of buried pipe and fittings.

2.2 VALVES

A. See Section 33 12 16 “Water Valves.”

2.3 VALVE BOX

A. Buried Valves in Traffic Areas: Cast iron two (2) piece slip sleeve type, 5-1/4 inch shaft, with a drop lid.

B. Buried Valves in Non-Traffic Areas: Cast iron two (2) piece screw adjustable sleeve of height required for installation.

C. Markings: Cast appropriate utility lettering on cover.

2.4 VALVE CHAMBER

A. Basin: Class 4000 concrete floor and walls.

B. Steps: Plastic, cast into sidewalls greater than four (4) feet deep.

C. Top: Flat slab class 4000 concrete.

D. Frame and Cover: Scoriated asphalt coated, heavy duty ductile iron with flat top design and appropriate utility lettering. Shape and size required.

2.5 MORTAR, GROUT, AND CONCRETE

A. Mortar: Portland cement, Section 04 05 16 “Masonry Mortar and Grout.”

B. Grout: Portland cement, Section 03 61 00 “Cementitious Grouting.”

C. Concrete:

1. Cast-in-place: Class 4000, Section 03 30 00 “Cast in Place Concrete.”

2. Precast: Class 5000, Section 03 40 00.

2.6 TAPPING SADDLES

A. Bronze alloy or stainless-steel saddles with stainless steel straps (double straps on pipes over 12 inches diameter).

B. Straight threads. Tapered threads not allowed.

C. Rated working pressure, 300 psi minimum.

D. Neoprene Buna N gaskets.

2.7 SERVICE CONNECTION

A. Taps: Saddle clamp or direct type. Provide plastic spacers or nipples to separate non-similar metals.

B. Service Line:

1. Copper Pipe: Type K, Section 33 05 03 “Copper Pipe” with 200 psi compression fittings according to AWWA C800.

2. Polyethylene Pipe: AWWA C901 with 200 psi compression fittings, and ratings according to AWWA C800.

C. Connection method: Use Electrofusion method for PE pipes, Push-fit or gasket joint for PVC pipes, Flanged joint for DI pipes. Provide jointing accessories required.

2.8 ACCESSORIES

A. Bolts, Nuts, Washers: Steel, Section 05 05 23 “Metal Fastenings.”

B. Anchorages: Provide anchorages for tees, wyes, crosses, plugs, caps, bends, valves, and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages.

C. Corporation Stops: All bronze, straight threads, full port, ball valve.

D. Hydrant and Valve: Dry barrel, Section 33 12 19 “Hydrants.”

E. Water Meter and Valve: Section 33 12 19 “Hydrants.”

F. Grease: Non—oxide food grade required where in contact with potable water. Non-oxide poly-fm for all exposed buried metal surfaces for bolts, nuts, washers, restraints, etc.

G. Polyethylene Sheet: Six (6) mil thick minimum.

H. Joint Restraints: Acceptable to ENGINEER prior to installation.

I. Tracer Wire: Provide tracer wire for non-metallic pipes to aid in locating buried pipes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify trench excavation is ready to receive work, and dimensions, and elevations are as required.

B. Commencing installation means acceptance of existing conditions.

3.2 PREPARATION

A. Excavation, Section 31 23 16 “Excavation.” Hand trim to required elevations. Correct over excavations.

B. Remove stones or other hard matter that manufacturer stipulates may damage pipe during embedment or impede backfilling or compaction.

C. Examine areas and conditions under which materials and products are to be installed. Do not proceed with system installation until unsatisfactory conditions have been corrected in manner acceptable to system installer.

D. Clearly identify and promptly set aside defective or damaged pipe.

E. Use pipe handling equipment to transport, load/unload and place the pipes. Do not drag, drop, roll or impact the pipes and fittings.

F. Use pipe cutting tool acceptable to pipe manufacturer.

3.3 LAYOUT

A. Comply with Utah administrative rules R309-550. As a minimum locate potable water pipe at least 18 inches vertical and 10 feet horizontal edge to edge between water and sewer lines. Place water lines above sewer line.

B. Where potable water pipe crosses under gravity-flow sewer lines, fully encase sewer pipe in concrete for a distance at least 10 feet each side of the crossing:

1. Do not locate any joint in the water line within 36 inches of the crossing.

2. Encase water line if it is within 24 inches of a sewer force main or a sewer inverted syphon.

3. Encase sewer main joints in concrete if joints are horizontally closer than 36 inches to the water line.

C. Do not put potable water lines in the same trench with sewer lines, storm drains or electric wires.

D. Locate fire hydrants at 500 feet interval along the main pipeline and at ends of branch pipelines.

3.4 INSTALLATION - PIPE AND FITTING

A. General:

1. Seal each open end of pipeline at end of day’s work.

2. Grease all bolts and nuts then apply polyethylene sheet and tape wrap.

B. Steel Pipe: AWWA M11.

C. Ductile Iron Pipe: AWWA C600.

D. Copper Tube: CDA "Copper Tube Handbook".

E. Polyethylene Pipe: For three (3) inches and smaller pipe follow AWWA C901. Install all other sizes per manufacturer's installation instructions.

F. Polyvinyl Chloride Pipe: AWWA C605.

G. Concrete Pipe: ACPA "Concrete Pipe Handbook".

H. Wedges: Install metal wedges on metal pipe systems. Grease and plastic wrap exposed metal wedges.

3.5 INSTALLATION — CONCRETE THRUST BLOCK

A. APWA Plan 561 or 562.

B. Do not make hydrostatic tests of Section 33 08 00 “Commissioning of Water Utilities” until thrust block concrete has cured for at least five (5) days.

C. Provide thrust blocks on all plugs, caps, tees, hydrants and vertical or horizontal elbows.

D. Provide stainless steel or epoxy coated steel tie rods and clamps or shackles to restrain thrust.

E. Unless indicated otherwise or directed by ENGINEER, place base and bearing sides of thrust blocking directly against undisturbed earth.

F. Sides of thrust blocking not subject to thrust may be placed against forms. Place thrust blocking so joint fittings will be accessible for repair.

3.6 INSTALLATION - VALVE AND VALVE BOX

A. Valves:

1. Ensure all parts are in working order.

2. Set location of valves outside of sidewalk limits, driveway approach and other pedestrian or vehicular interference.

3. Install plumb with stem pointing up.

4. Grease all exposed bolts and nuts then apply polyethylene sheet and tape wrap.

B. Air Relief Valves:

1. At high points in water mains where air can accumulate, air may be removed by means of hydrants or air relief valves.

2. DO NOT use automatic air relief valves where flooding may occur.

C. Valve Box:

1. Set over valve nut so operator's key is plumb with clearance in valve box when opening and closing the valve. Riser must NOT rest on valve or pipe system.

2. Adjust riser to finish grade and clean all dirt or foreign material out of riser.

3. Install concrete cover collar in bituminous paved surface APWA Plan 574.

3.7 INSTALLATION — JOINT RESTRAINTS

A. Without Thrust Blocks: Install joint restraints with all valves for the distance acceptable to the ENGINEER.

B. With Thrust Blocks: Install joint restraints for the distance approved by the ENGINEER where concrete block design exceeds three (3) cubic yards, for vertical bends, where soil is disturbed, or where undisturbed soil bearing capacity is less than 1000 pounds per square foot.

C. Provide joint restraints on each side of fittings like tees, bends, reducers and end caps.

3.8 INSTALLATION — TAPS

A. APWA Plan 551 or 552.

B. Apply for and pay for applicable permits from water company for size and location of tap to water main. Comply with all connection requirements of water company.

C. Make service taps with a tapping machine acceptable to water company. Use teflon tape on all taps unless indicated otherwise.

D. Minimum distance between taps is 24 inches, with a five (5) degree stagger. Do not make service taps within 24 inches of the end of pipe. Install taps at 60 degrees from vertical, or authorized by ENGINEER.

E. Service saddles are required on all taps except, 3/4 inch or 1 inch taps to new ductile iron pipe.

F. Grease all exposed bolts and nuts then apply six (6) mil thick polyethylene sheet and tape wrap.

3.9 INSTALLATION — SERVICE LINE

A. Replacing Existing Water Service Line: APWA Plan 541.

1. Follow AWWA C800, Utah drinking water Rules and Regulations and International Building Code requirements.

2. When replacing water service lines, replace non-copper pipe with:

a. Type K copper pipe, Section 33 05 03 “Copper Pipe”, or

b. Polyethylene pipe, AWWA C901

3. Minimum pipe diameter 3/4 inch, maximum 3 inches.

4. Distance from nearest joint or existing tap is 24 inches minimum unless a greater distance is required by pipe manufacturer.

B. Backflow Preventer: Install a backflow preventer at the service connection point.

C. Looping Existing Water Service: APWA Plan 542.

1. Minimum pipe diameter is one (1) inch.

2. Use liquid nitrogen to spot freeze active service lines. Pinching tools used to close active service lines may be used only if allowed in writing by ENGINEER.

3. Soldered joints or connections not allowed.

4. For copper to iron connections use a brass pack joint compression coupling with joint locking device.

5. For copper-to-copper connections use a brass compression fittings. Flared end fittings are not allowed.

D. Meter box: APWA Plan 521 or 522. Install meter box back of curb, outside of sidewalk, outside of driveway approaches, or other vehicular or pedestrian interference.

3.10 INSTALLATION — WATER MAIN LOOP (SYPHON)

A. APWA Plan 543.

B. Existing water mains may not match standard size. Excavate to obtain actual pipe diameter and match size.

C. Do not shutdown pipeline until couplings and fittings are on site. Coordinate shutdown with water company.

D. Connections to steel or transite pipe require transition couplings or sleeves with transition gaskets.

E. Grease all exposed bolts and nuts then apply six (6) mil thick polyethylene sheet and tape wrap.

F. Before backfilling, ensure that the joints are visible for inspection and testing.

G. Provide thrust blocks except where joints are welded. Follow details shown on drawings.

3.11 TESTING

A. Perform hydrostatic pressure testing and leakage testing of the installed pipeline according to AWWA C600 for DI pipes, AWWA C605 for PVC pipes, and ISO 4427 for PE pipes. Record and submit the test results.

B. Perform disinfection of the pipeline as per AWWA C651.

C. Provide certified reports of tests conducted.

3.12 AS-BUILT DOCUMENTS

A. Provide as-built drawings showing the exact route, depth, and location of all pipelines, fittings, valves, and other components of the water distribution system.

B. Record the GPS coordinates of all important points and include them in the as-built documents.

3.13 DISINFECTION

A. See Section 33 13 00 “Disinfection.”

B. After disinfection, legally dispose of disinfection water.

3.14 BACKFILLING

A. Before backfilling secure ENGINEER's acceptance of brass wedge installations and concrete thrust block installations.

B. Trenches and Pot-holes: Follow requirements in Section 33 05 20 "Backfilling Trenches" and the following Standard Plans.

1. APWA Plan 382 for the pipe zone.

2. APWA Plan 381 for the trench backfill.

C. Landscapes and Structural Backfill: Follow Section 31 23 23 "Backfilling for Structures" requirements.

3.15 COMMISSIONING

A. Before surface finishing, commission pipeline per Section 33 08 00 "Commissioning of Water Utilities." Provide sizes and types of equipment connections and fittings that match pipe materials when pressure testing system.

B. If paved surfaces must be kept open prior to commissioning, provide temporary paved surfaces.

3.16 SURFACE FINISHING

A. Roadway Trenches and Patches: Follow requirements in Section 33 05 25 "Pavement Restoration" and in the following Standard Plans:

1. APWA Plan 255 for bituminous concrete T-patch.

2. APWA Plan 256 for concrete pavement patch.

B. Landscapes: Restore landscaping as indicated and as follows where applicable.

1. Section 32 92 00 "Turf and Grass" for turf and grasses.

2. Section 32 93 13 "Ground Cover" for other ground cover.

C. Repair public and private facilities damaged by CONTRACTOR.

3.17 CLEANING

A. Remove debris, concrete, or other extraneous material that accumulates in existing piping or structures.

B. Clean all pipelines after testing. Do not flush sand, gravel, concrete, debris, or other materials into existing piping systems.

3.18 DOCUMENTATION

A. Submit test reports, installation records, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed water distribution and transmission system.

END OF SECTION

SECTION 33 16 13

WATER TANK

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. On grade welded steel water storage tank.
2. Foundation and ring wall construction.
3. Testing requirements.

1.2 RELATED SECTIONS

31 05 13 “Common Fill”

03 20 00 “Concrete Reinforcing”

03 30 00 “Cast in Place Concrete”

32 11 23 “Aggregate Base Course”

31 23 26 “Compaction”

33 13 00 “Disinfection”

1.3 REFERENCES

A. ASME Standards:

1. Boiler and Pressure Vessel Code.

B. AWWA Standards:

1. D100 Welded Steel Tanks for Water Storage.

1.4 SUBMITTALS

A. List of five (5) tanks, including name of owner, size, location, and year completed.

B. Certification of welders who will be performing welding.

C. Within 30 days after award of contract, furnish two (2) sets of design calculations and four (4) sets of detail drawings of the tank. Furnish drawings prepared by a licensed design professional.

1.5 QUALITY ASSURANCE

A. Welder Certification:

1. Use only welders qualified in all positions by ASME Boiler and Pressure Vessel Code.

2. Maintain a record of welds and welders employed on each joint.

3. Provide a welding supervisor independent of the tank erection foreman's jurisdiction.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 – PRODUCTS

2.1 GENERAL

A. Furnish a steel tank that is fabricated and erected per AWWA D100 and governing Laws and Regulations.

B. Furnish the tank per Appendix C of AWWA D100. Use a design temperature based on a low one (1) day mean temperature of -10 deg F if not indicated elsewhere.

2.2 TANK ACCESSORIES

A. General: Furnish and install all tank accessories as indicated and as applicable below.

B. Ladder: One fixed ladder with safety cable on the exterior of the tank conforming to OSHA. Extend ladder eight (8) feet above ground surfaces to roof.

C. Shell Manholes: Two 24 inches diameter shell manholes equipped with davits or hinges located near base of tank. Furnish one manhole with a bolting flange for an exhaust fan for ventilation as indicated in AWWA D100.

D. Vent: Mushroom vent of adequate size to handle pressure differential cause by water entering or leaving the tank at the maximum rate indicated. Do not consider the open area of overflow as venting area. Provide a special screened vent to ensure fail-safe operation if screen frosts over or is otherwise clogged. Furnish a vent that is easily dismantled to remove screens for cleaning.

E. Roof Manholes: One 36 inch rainproof roof hatch with hinges and hasp for locking per AWWA D100 and a 24 inch diameter roof manhole with a removable cover.

F. Overflow: Provide tank overflow. Equip overflow with an anti—vortex entrance. Extend overflow down outside of tank.

G. Inlet Nozzle: Equip with a 125 psi working pressure flange connection.

H. Bottom Drain: Weld drain to tank bottom and make required connections.

I. Outlet Nozzle: Equip with a 125 psi working pressure flange connection.

2.3 FILL MATERIALS UNDER TANK

A. Well-graded, sandy gravel with a two (2) inch maximum size for filling inside the ringwall.

B. 4 inch thick layer of oiled sand, Section 31 05 13 “Common Fill” directly under the tank floor.

2.4 REINFORCEMENT AND CONCRETE

A. Reinforcement: Steel Section 03 20 00 “Concrete Reinforcing.”

B. Concrete: Class 3000 minimum cast-in-place, Section 03 30 00 “Cast in Place Concrete.”

PART 3 – EXECUTION

3.1 ERECTION

A. AWWA D100.

3.2 RADIOGRAPHS

A. AWWA D100. Inspection, by CONTRACTOR.

B. Spot radiographs are to be taken, AWWA D100. Preplanned sections will not be allowed.

C. Provide an independent evaluation of radiographs by a person qualified to read and evaluate radiographs.

D. Provide ENGINEER access to all radiographic film. After completion of structure, films become property of OWNER.

E. Before any repair of welds, submit radiographs with such information as required.

F. Repair all welds by grinding out bad areas and rewelding. Do a second radiograph at the same location.

3.3 ROOF AND FLOOR TESTS

A. Use vacuum box testing on all floor and roof fillet welds.

B. Report results in writing.

3.4 TANK TOLERANCES

A. Test for:

1. Plumbness: The maximum variation from plumb of the top of the shell relative to the bottom of the shell shall not exceed 1/200 of the total tank height.

2. Roundness: Radii measured at 1'-0" above the bottom corner weld; a tolerance of 3/4 inch.

3. Peaking: Using a horizontal sweep board 36 inches long, peaking less than 1/2 inch.

4. Banding: Using a vertical sweep board 36 inches long, banding less than 1/2 inch.

B. Be responsible for providing all equipment necessary to check these dimensional tolerances.

3.5 CONCRETE RINGWALL CONSTRUCTION

A. General: Pour ringwall monolithically.

B. Ringwall Tolerance: Level top of ringwall to within 1/8 inch in any 30 feet of circumference and within 1/4 inch in total circumference.

C. Interior Backfilling: Below ringwall and tank bottom, use Section 32 11 23 “Aggregate Base Courses” untreated base course. Compact backfill to 95 percent or greater relative to a modified proctor density, Section 31 23 26 “Compaction.”

D. Exterior Backfilling: Use Section 31 05 13 “Common Fill” common fill which is free of trash, trees, roots, organic material, broken concrete, or other objectionable material. Compact backfill to 90 percent or greater relative to a standard proctor density, Section 31 23 26 “Compaction.”

3.6 TANK FINISHING AND PAINTING

A. Color as indicated or selected by contract documents or ENGINEER.

3.7 TANK TESTING

A. Close all tank outlets, inspection holes, or other openings below water level.

B. Fill tank to maximum working water depth and let set for 48 hours.

C. Measure change in water depth over next five (5) day period. Take measurement at least once every 24 hours.

D. Mark any leaks or damp areas for later repair.

E. If the drop in the water exceeds 0.25 percent of tank volume repair and retest.

F. Repair all observed leaks or damp areas and retest full tank again until the tank passes.

3.8 TANK STERILIZATION

A. Disinfection, Section 33 13 00 “Disinfection.”

3.9 FIELD QUALITY CONTROL

A. Perform coating and lining tests to ensure proper application and adherence.

B. Conduct structural inspections to verify compliance with design specifications.

C. Perform inspections at various stages of installation to ensure compliance with project specifications and industry standards.

D. Document all test results and inspection findings.

E. Obtain final approval and acceptance of the installed tanks.

3.10 CLEANING

A. Remove excess material and debris from the site.

B. Clean the surface of the tank to remove dirt, stains, and other contaminants.

3.11 DOCUMENTATION

A. Submit test reports, installation records, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed tanks.

END OF SECTION

SECTION 33 05 02

CONCRETE PIPE AND CULVERT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Reinforced and non-reinforced concrete pipe and culvert, fittings and joint materials.

1.2 RELATED SECTIONS

03 61 00 “Cementitious Grouting”

04 05 16 “Masonry, Mortar, and Grout”

32 84 23 “Underground Irrigation Systems”

33 05 20 “Backfilling Trenches”

33 11 00 “Water Distribution and Transmission”

33 31 00 “Sanitary Sewerage Systems”

33 41 00 “Drainage Systems”

1.3 REFERENCES

B. AASHTO Standards:

1. HB-17 Highway Bridges.
2. LRFD Bridge Design Specifications, Customary U.S. Units.
3. M198 Joints for Concrete Pipe, Manholes, and Precast Box.
    a. Sections using Preformed Flexible Joint Sealants.

C. ASTM Standards:

1. C14 Concrete Sewer, Storm Drain, Culvert Pipe.
2. C76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
3. C118 Concrete Pipe for Irrigation or Drainage.
4. C150 Portland Cement.
5. C36l Reinforced Concrete Low-Head Pressure Pipe.

6. C4l2 Concrete Drain Tile.
7. C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
8. C444 Perforated Concrete Pipe.
9. C497 Testing Concrete Pipe, Sections, or Tile.
10. C505 Non-Reinforced Concrete Irrigation Pipe with Rubber Gasket Joints.
11. C507 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
12. C654 Porous Concrete Pipe.
13. C655 Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe.
14. C985 Non-reinforced Concrete Specified Strength Culvert, Storm Drain, and Sewer Pipe.
15. C1433 Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers. (Designed according to AASHTO BH-17).
16. C1479 Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.
17. C1504 Precast Reinforced Concrete 3 Sided Structures for Culverts and Storm Drains.
18. C1577 Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewer (Designed according to AASHTO LRFD).

D. AWWA Standards:

1. C302 Reinforced Concrete Pressure Pipe, Non-cylinder Type, for Water and Other Liquids.

1.3 SUBMITTALS

A. Precast box culvert design summary.

B. Manufacturer’s proof of certification.

1.4 QUALITY ASSURANCE

A. Pipe:

1. Remove and replace pipe that show exposed reinforcing steel, honeycomb or open texture.

2. Repair or replace reinforced concrete pipe if cracks are greater than 0.10 inch.

1.5 ACCEPTANCE

A. Not Applicable.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Pipes, fittings, and joint materials should be delivered, stored, and handled in accordance with the manufacturer's instructions. Any damaged or defective materials are to be replaced at the contractor's expense.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Provide type, class, strength and size of pipe and fittings required.

B. Concrete:

1. Use ASTM C150 or C1157 cement unless required otherwise.

2. Admixtures and pozzolans may be used only with approval.

C. Gravity Pipe System:

1. Reinforced Concrete Pipe: ASTM C76 or ASTM C655.

a. Within the trackway: Class V, Wall C per ASTM C76.

2. Non-reinforced Pipe: ASTM C14 in sizes up to 36" diameter and ASTM C985 for pipe up to 60" diameter.

3. Irrigation or Drainage Pipe: ASTM C118 or ASTM C505.

4. Drainage Tile: ASTM C412.

5. Perforated Pipe: ASTM C14 Type 1 Class 2 or ASTM C444.

6. Elliptical Pipe: ASTM C507.

7. Porous Concrete Pipe: ASTM C654.

8. Perforated Concrete Pipe: ASTM C444.

9. Precast Box Section Bridge: ASTM C1433 or ASTM C1577 as applicable.

10. Three Sided Culvert: ASTM C1504.

D. Low Head Pressure Pipe Systems: ASTM C361 or AWWA C302.

2.2 JOINTS

A. Use ASTM C443 rubber gasket bell and spigot type joints.

B. For box sections use tongue and groove joints with bituminous mastic joint sealant.

C. For elliptical sections use tongue and groove joints with bituminous mastic joint sealant, AASHTO M198.

D. Mortar: Mortar and Grout, Section 04 05 16.

2.3 SOURCE QUALITY CONTROL

A. Pipe and tile, ASTM C497.

B. Box sections, ASTM C1433.

C. Three sided culverts, ASTM C1504.

2.4 ACCESSORIES

A. Provide all necessary accessories such as joint sealants, grout, mastic, and others as recommended by the manufacturer and in accordance with the referenced standards.

PART 3 - EXECUTION

3.1 FACTORY FITTINGS

A. Fit all service tees and other miscellaneous fittings with an expanding plug.

B. Grout all fittings to provide a smooth interior and exterior surface.

C. When providing pipe or box sections specifically manufactured with branch connections, carefully shape and fit adjoining pieces to facilitate grouting. Grout all fittings to provide a smooth interior and exterior surface. Lateral pipe or sections shall not project beyond the inner surface of pipe.

D. Use epoxy adhesive grout, Section 03 61 00 as interface between new and existing concrete and piping materials.

3.2 INSTALLATION - PIPE AND FITTINGS

A. Assembly: Abide by manufacturer's instructions, ASTM C1479, and the following. Use the more stringent provisions if there are any conflicts.

1. Pressurized Systems:

    a. Water distribution and transmission, Section 33 11 00.

    b. Underground irrigation, Section 32 84 23.

2. Gravity Systems:

    a. Sanitary sewers, Section 33 31 00.

b. Under drains and storm drains, Section 33 41 00.

B. Burial: Comply with Section 33 05 20 and the following.

1. Place circular concrete pipe that contains elliptical reinforcing so that the reference lines designating the top of the pipes will not be more than five (5) degrees from the vertical plane through the longitudinal axis of the pipe.

C. Trenching and Backfill: The trenching, bedding, and backfill for pipe installations should be in compliance with the standards and regulations of the local governing authority, manufacturer's recommendations, and as specified in Section 31 23 00.

3.3 INSTALLATION - BOX SECTIONS

A. Assembly: Abide by manufacturer's instructions, and Section 33 41 00 for under drains and storm drain systems. Use the more stringent provisions if there are any conflicts.

1. Install per manufacturer’s instructions.

2. Provide a leveling course under box section. Use Sewer Rock unless specified otherwise.

3. Pull sections together using internal winches or tugger. Do not push box section together. Pushing causes joint misalignment.

4. Limit joint gap to maximum specified by manufacturer. Remove excess bituminous mastic joint sealant from interior box wall, floor, and ceiling.

B. Burial: Comply with Section 33 05 20.

3.4 INSPECTION AND TESTING

A. Perform a visual inspection of all pipes and fittings before installation to ensure they are free from visible defects. Defected materials should not be used and must be replaced.

B. Perform testing of the installed pipe system in accordance with local code and manufacturer's recommendations to ensure it is leak-free and functioning as expected.

3.5 REPAIR AND MAINTENANCE

A. Provide a regular inspection and maintenance schedule based on the manufacturer's recommendation to ensure the longevity and efficient operation of the pipe system.

B. Any damaged or leaking pipes identified during the maintenance checks should be replaced or repaired in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 33 31 00

SANITARY SEWERAGE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Installation of a buried non-pressure sanitary sewer pipe system.
2. Refer to Section 33 11 00 if installation is a pressurized pipe system.

1.2 RELATED SECTIONS

03 30 00 “Cast in Place Concrete”

03 40 00 “Precast Concrete”

03 61 00 “Cementitious Grouting”

04 05 16 “Masonry Mortar and Grout”

31 23 23 “Backfilling for Structures”

31 23 26 “Compaction”

32 92 00 “Turf and Grass”

32 93 13 “Ground Cover”

33 05 20 “Backfilling Trenches”

33 05 25 “Pavement Restoration”

33 08 00 “Commissioning of Water Utilities”

33 11 00 “Water Distribution and Transmission”

33 41 00 “Drainage Systems”

1.3 REFERENCES

A. APWA (Utah) Standards:

1. Plan 255 Bituminous concrete T-patch
2. Plan 256 Concrete pavement patch
3. Plan 381 Trench backfill
4. Plan 382 Pipe zone backfill

5. Plan 41 l Sanitary sewer manhole

6. Plan 431 Sewer lateral connection

B. ASTM Standards:

1. C478 Precast Reinforced Concrete Manhole Section.

2. C891 Installation of Underground Precast Concrete Utility Structures.

3. C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

1.4 SUBMITTALS

A. Product data: Submit manufacturer's technical product data and installation instructions.

B. Commissioning: Provide Section 33 08 00 "Commissioning of Water Utilities" submittals.

1.5 QUALITY ASSURANCE

A. Not Applicable.

1.6 ACCEPTANCE

A. Each sanitary sewer system component must pass applicable commissioning requirements in Section 33 08 00 "Commissioning of Water Utilities."

1.7 DEFINITIONS

A. Non-pressure Pipe System: Defined in Section 33 41 00.

1.8 PERFORMANCE REQUIREMENTS

A. Vertical Cover: Unless indicated otherwise, provide at least two (2) feet of protection cover during construction.

B. Remove any section of pipe already placed that is found to be out of alignment tolerance, defective, or damaged. Relay or replace at no additional cost to OWNER.

1.9 SITE CONDITIONS

A. Minimize neighborhood traffic interruptions. Barricade stockpiles.

B. Provide access to adjacent properties for local traffic and pedestrians.

1.10 SAEFETY REQUIRMENTS

A. Contractor must comply with all OSHA safety regulations and local safety codes.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. Provide piping materials and factory fabricated piping products of sizes, types, and classes required.

B. Where not indicated, select product acceptable to ENGINEER and comply with installation requirements.

C. Provide pipe fittings and accessories of same material and weight or class as pipe, with joining method indicated or recommended by manufacturer.

2.2 MORTAR, GROUT AND CONCRETE

A. Portland cement mortar, Section 04 05 16 “Masonry Mortar and Grout.”

B. Non-shrink grout, Section 03 61 00 “Cementitious Grouting.”

C. Concrete:

1. Cast-in-place: Section 03 30 00 “Cast in Place Concrete.”

2. Precast Concrete: Section 03 40 00.

2.3 MANHOLES

A. Basin: Concrete floor and walls, or ASTM C478 precast concrete.

B. Steps: None.

C. Top: Concentric cone. Concentric flat slab concrete deck allowed only with ENGINEER’s permission.

D. Frame and Cover: Scoriated, asphalt coated, heavy duty, ductile iron with flat top design meeting load rating H-20 and appropriate utility lettering. Shape, size and lifting device as necessary.

E. Pipe Connectors:

1. Precast Bases: Resilient, ASTM C923. Sand mortar grout pipe connections.

2. Cast in Place or Connections to Existing Fixture with Plastic Pipe: Use rubber adapter gasket for precast sections. Grout, Section 03 61 00 for cast in place sections.

F. Joints in Sections: Bituminous mastic gasket-type sealant or otherwise acceptable to ENGINEER.

2.4 PIPE BEDDING

A. Provide pipe bedding materials as per local building codes and pipe manufacturer's recommendations.

2.5 PIPE INSULATION

A. Provide pipe insulation for pipes installed in areas exposed to freezing temperatures, conforming to ASTM C547.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify Trench Excavation is ready to receive work, and dimensions, and elevations are correct. Commencing installation means acceptance of existing conditions.

B. Hand trim excavations to required elevations. Backfill over excavations and compact, Section 31 23 26 “Compaction.”

C. Examine areas and conditions under which materials and products are to be installed. Do not proceed with system installation until unsatisfactory conditions have been corrected in manner acceptable to system installer.

D. Clearly identify and promptly set aside defective or damaged pipe.

E. Use pipe cutting tool acceptable to pipe manufacturer.

F. Identify and locate all existing underground utilities prior to commencement of any excavation work. Utilize ground penetrating radar or other suitable technologies for this purpose.

3.2 ABANDONED UTILITIES

A. Use concrete to plug and cap openings in abandoned underground utilities that are to remain in place.

B. Provide closures to withstand hydrostatic or earth pressure that may result after abandoned utilities have been closed.

3.3 INSTALLATION - PIPE AND FITTINGS

A. Install pipe and fittings per APWA Plan 382.

B. Place bell or groove end facing upstream.

C. Install gaskets per manufacturer's recommendations.

D. Plug pipeline branches, stubs or other open ends that are not to be immediately connected.

E. Clean interior of pipe of dirt and debris as work progresses.

F. Meet line and grade tolerance in Section 33 08 00. Use a laser device or demonstrate an equivalent method of establishing line and grade.

3.4 INSTALLATION – JOINTS

A. Join pipe per manufacturer's recommendation.

B. Join pipe of different sizes at manholes only.

C. Use neoprene couplings with stainless steel bands to make connections between dissimilar pipe, or where standard pipeline joints are impractical.

3.5 INSTALLATION – MANHOLES

A. Install manholes per APWA Plan 411.

B. Form bottom of excavation clean and smooth to correct elevation.

C. Place structures in location indicated.

D. Provide elevations and pipe inverts for inlets and outlets indicated.

E. When structures occur in Pavements, mount frame and cover 1/2 inch below finished surface. Provide a concrete Cover Collar between the frame and bituminous Pavement. Elsewhere set frame and cover three inches above finished grade.

3.6 INSTALLATION - TAP CONNECTIONS-6 INCHES AND SMALLER

A. Install connections per APWA Plan 431.

B. Field cutting into new or existing piping will not be permitted unless written permission is obtained from ENGINEER.

C. Make connections to existing pipe and underground structures, so connections will conform as nearly as practicable to requirements specified for new work.

D. Use commercially manufactured wyes for branch connections. Spring wyes into existing line and encase entire wye, plus six (6) inches overlap, with not less than six (6) inches of concrete.

E. For taps into existing 24 inches or larger piping, or to underground structures, cut opening into unit sufficiently large to allow three (3) inches of concrete to be packed around entering connection. Cut ends of connection passing through pipe or structure wall to conform to shape of and parallel with inside wall, unless otherwise indicated. Grout connection to provide smooth transition inlet into pipe.

3.7 INSTALLATION - TAP CONNECTIONS-LARGER THAN 6 INCHES

A. Not allowed. Provide a Manhole structure per APWA Plan 411.

3.8 BACKFILLING

A. Trench Backfill: Place backfill per Section 33 05 20 “Backfilling Trenches.” Provide product and placement indicated in the following Standard Plans.

1. APWA Plan 382 for pipe zone backfill.

2. APWA Plan 381 for trench backfill above pipe zone.

B. Landscape and Structural Backfill: Place backfill per Section 31 23 23 “Backfilling for Structures.” Provide product and placement indicated.

C. Repair public and private facilities damaged by CONTRACTOR.

3.9 SURFACE FINISHING

A. Roadway Trenches and Patches: Restore pavement patches per Section 33 05 25 “Pavement Restoration.” Provide product and placement indicated in the following standard plans.

1. APWA Plan 255 for bituminous pavement T-patch.

2. APWA Plan 256 for Portland cement concrete pavement patch.

B. Landscapes: Restore landscaping as indicated and as follows where applicable.

1. Section 32 92 00 “Turf and Grass” for turf and grass cover.

2. Section 32 93 13 “Ground Cover” for other ground cover.

C. Repair public and private facilities damaged by CONTRACTOR.

3.10 COMMISSIONING

A. Before surface finishing, commission pipeline per Section 33 08 00 “Commissioning of Water Utilities.” Provide sizes and types of equipment connections and fittings that match pipe materials when pressure testing system.

B. If paved surfaces must be kept open prior to commissioning, provide temporary paved surfaces.

C. In case of discrepancies or conflicts between testing requirements specified here and those specified by the manufacturer, the stricter of the two shall govern.

3.11 CLEANING

A. Remove debris, concrete, or other extraneous material that accumulates in existing pipes or structures.

B. Clean all pipelines after testing. Do not flush sand, gravel, concrete, debris, or other materials into existing piping systems.

3.12 FIELD QUALITY CONTROL

A. Conduct low-pressure air tests on installed pipes and manholes to ensure leak-free performance, conforming to ASTM C924 or ASTM F1417 as applicable.

B. Perform hydrostatic tests where specified.

C. Conduct deflection tests on flexible pipes to ensure compliance with specified limits.

D. Perform inspections at various stages of installation to ensure compliance with project specifications and industry standards.

E. Document all test results and inspection findings.

3.13 DOCUMENTATION

A. Submit test reports, installation records, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of installed systems.

3.14 CONFLICTS

A. Conflicts between specifications and applicable codes and standards: Comply with the most stringent requirements.

END OF SECTION

SECTION 33 41 00

DRAINAGE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Installation of a buried non-pressure pipe system such as a storm drain, a sub-drain, irrigation, etc.

2. Refer to Section 33 11 00 “Water Distribution and Transmission” if the installation is a pressurized pipe system.

1.2 RELATED SECTIONS

03 30 00 “Cast in Place Concrete”

03 40 00 “Precast Concrete”

03 61 00 “Cementitious Grouting”

04 05 16 “Masonry Mortar and Grout”

05 12 00 “Structural Steel Framing”

31 05 13 “Common Fill”

31 05 19 “Dewatering”

31 23 26 “Compaction”

31 37 00 “Riprap Rock Lining”

32 11 23 “Aggregate Base Course”

32 92 00 “Turf and Grass”

32 93 13 “Ground Cover”

33 05 20 “Backfilling Trenches”

33 05 25 “Pavement Restoration”

33 08 00 “Commissioning of Water Utilities”

33 11 00 “Water Distribution and Transmission”

1.3 REFERENCES

A. APWA (Utah) Standards:

1. Plan 255 Bituminous concrete T-patch
2. Plan 256 Concrete pavement patch
3. Plan 315 Catch basin (single or double grate)
4. Plan 317 Curb face inlet box
5. Plan 322 Curb face outlet box
6. Plan 323 Pipe outfall
7. Plan 331 Cleanout box
8. Plan 341 Precast manhole
9. Plan 381 Trench backfill
10. Plan 382 Pipe zone backfill

B. ASTM Standards:

1. C478 Precast Reinforced Concrete Manhole Section.
2. C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

1.4 SUBMITTALS

A. Product data: Submit manufacturer's technical product data and installation instructions.

B. Commissioning: Provide Section 33 08 00 “Commissioning of Water Utilities” submittals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed drainage systems that are similar in material, design, and extent to those indicated for this Project and that have resulted in construction with a record of successful in-service performance.

B. Regulatory Requirements: Comply with requirements of the following:

1. Local, state, and federal rules and regulations.
2. National Fire Protection Association (NFPA).
3. Occupational Safety and Health Administration (OSHA).

1.6 ACCEPTANCE

A. Each drainage system component must pass applicable commissioning requirements in Section 33 08 00 “Commissioning of Water Utilities.”

1.7 DEFINITIONS

A. Non-pressure Pipe System: Pipelines with joints that have no leakage after a sustained hydraulic pressure not exceeding 10.8 psi (22 in. Hg) for 10 minutes or a sustained vacuum pressure not exceeding 3 kPa (5 in. Hg) for 10-minutes.

1.8 PERFORMANCE REQUIREMENTS

A. Vertical Cover: Unless indicated otherwise, provide at least two (2) feet of protection cover during construction.

B. Remove any section of pipe already placed that is found to be out of alignment tolerance, defective, or damaged. Relay or replace without additional cost to OWNER.

1.9 SITE CONDITIONS

A. Minimize neighborhood traffic interruptions. Barricade stockpiles.

B. Provide access to adjacent properties for local traffic and pedestrians.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. Provide piping materials and factory fabricated piping products of sizes, types, and classes required.

B. Where not indicated, select product acceptable to ENGINEER and comply with installation requirements.

C. Provide pipe fittings and accessories of same material and weight or class as pipe, with joining method indicated or recommended by manufacturer.

2.2 IN-PLANE WALL DRAINAGE

A. Drainage Core: Manufacturer's standard three-dimensional non-bio-degradable, plastic designed to effectively conduct water to foundation drainage system.

B. Filter Fabric: Manufacturer's standard non-woven geotextile fabric of polypropylene or polyester fibers, or combination.

2.3 SUB DRAIN FILL MATERIALS

A. Sewer rock, Section 32 11 23 “Aggregate Base Courses” and geotextile, Section 31 05 19 “Geotextiles.”

2.4 MORTAR, GROUT AND CONCRETE

A. Portland cement mortar, Section 04 05 16 “Masonry Mortar and Grout.”

B. Non-shrink grout, Section 03 61 00 “Cementitious Grouting.”

C. Concrete:

1. Cast-in-place: Section 03 30 00 “Cast in Place Concrete.”

2. Precast Concrete: Section 03 40 00.

2.5 MANHOLES

A. Basin: Concrete floor with cast in place concrete walls or ASTM C478 precast concrete.

B. Steps: None.

C. Top: Concentric cone. Concentric flat slab concrete deck allowed only with ENGINEER’s permission.

D. Frame and Cover: Scoriated, asphalt coated, heavy duty, ductile iron with flat top design meeting load rating H-20 and appropriate utility lettering. Shape, size and lifting device as necessary.

E. Pipe Connectors:

1. Precast Bases: Resilient, ASTM C923. Sand mortar grout pipe connections.

2. Cast in Place or Connections to Existing Fixture with Plastic Pipe: Use rubber adapter gasket for precast sections. Grout, Section 03 61 00 “Cementitious Grouting” for cast in place sections.

F. Joints in Sections: Bituminous mastic gasket-type sealant or otherwise acceptable to ENGINEER.

2.6 INLETS, CATCH BASINS, CLEANOUTS

A. Basin: Concrete floor and walls.

B. Pipe Connectors: Resilient, ASTM C923. Sand mortar grout.

C. Frame and Grate:

1. Asphalt coated, heavy duty, cast iron. Shape and size indicated.

2. Galvanized, heavy duty, steel: Sections 05 12 00 “Structural Steel Framing.”

2.7 OUTFALLS

A. Cast-in-place or precast concrete with reinforced headwall, apron, and tapered sides. Provide riprap, Section 31 37 00 “Riprap or Rock Lining”, if indicated.

2.8 DRAINPIPE JOINT SCREENS

A. Heavy mesh burlap, coal-tar saturated felt, 18 to 14 mesh copper screening or synthetic drainage fabric.

B. Plastic or corrosion resistant metal bands.

2.9 PROTECTION MATERIALS

A. Protective coatings and linings for manholes, pipes, fittings, and other components that will be in contact with sewage or effluents, or are specified to be coated or lined, shall resist corrosive and abrasive effects of materials and conditions to which drainage system components are exposed.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify Trench Excavation is ready to receive work, and dimensions, and elevations are correct. Commencing installation means acceptance of existing conditions.

B. Hand trim excavations to required elevations. Backfill over excavations and compact, Section 31 23 26 “Compaction.”

C. Remove stones larger than two (2) inches or other hard matter that could damage pipe or impede backfilling or compaction.

D. Examine areas and conditions under which materials and products are to be installed. Do not proceed with system installation until unsatisfactory conditions have been corrected in manner acceptable to system installer.

E. Clearly identify and promptly set aside defective or damaged pipe.

F. Use pipe cutting tool acceptable to pipe manufacturer.

3.2 ABANDONED UTILITIES

A. Use concrete to plug and cap open ends of abandoned underground utilities that are to remain in place.

B. Provide closures to withstand hydrostatic or earth pressure that may result after ends of abandoned utilities have been closed.

3.3 INSTALLATION - PIPE AND FITTINGS

A. Place bell or groove end facing upstream.

B. Install gaskets per manufacturer's recommendations.

C. Plug pipeline branches, stubs or other open ends that are not to be immediately connected.

D. Clean interior of pipe of dirt and debris as work progresses.

E. Insulate dissimilar metals from direct contact with each other using neoprene gaskets or asphalt coatings.

F. Meet line and grade tolerance in Section 33 08 00 “commissioning of Water Utilities.” Use a laser device or demonstrate an equivalent method of establishing line and grade.

3.4 INSTALLATION – JOINTS

A. Join pipe per manufacturer's recommendation.

B. Join pipe of different sizes at manholes or cleanouts only.

C. Use neoprene couplings with stainless steel bands to make connections between dissimilar pipe, or where standard pipeline joints are impractical.

3.5 INSTALLATION – MANHOLES

A. Install manholes per APWA Plan 341.

B. Form bottom of excavation clean and smooth to correct elevation.

C. Place structures in location indicated.

D. Provide elevations and pipe inverts for inlets and outlets indicated.

E. When structures occur in Pavements, mount frame and cover 1/2 inch below finished surface. Provide a concrete Cover Collar between the frame and bituminous concrete pavement. Elsewhere set frame and cover three (3) inches above finished grade.

3.6 INSTALLATION - INLETS, CATCH BASINS, CLEANOUTS

A. Install facilities per APWA Plans 315, 316, 317, 331.

B. Form bottom of excavation clean and smooth to correct elevation.

C. Construct with all connecting piping and appurtenances in their final position.

D. Cut all piping parallel to interior surface wall. Grout connection to provide smooth transition inlet into pipe.

3.7 INSTALLATION SUB DRAIN SYSTEMS

A. Install pipe and fittings per manufacturer's requirements.

B. Open Joint Systems: Loosely butt pipe ends. Place 12 inches wide filter fabric around pipe circumference, centered over joint.

C. Mechanical Joint Perforated Pipe System: Place pipe with perforations facing down.

D. Place drainage pipe on bed of sewer rock, Section 31 05 13 “Common Fill.”

3.8 INSTALLATION - TAP CONNECTIONS

A. Not allowed in storm drain systems. Provide a cleanout or manhole structure.

3.9 INSTALLATION – OUTFALLS

A. Install outfalls per APWA Plans 322 and 323.

3.10 INSTALLATION - AREA DRAINS

A. Install area drains per APWA Plan 372.

3.11 BACKFILLING

A. Trench Backfill: Place backfill per Section 33 05 20 “Backfilling Trenches.” Provide product and placement indicated in the following Standard Plans.

1. APWA Plan 382 for pipe zone backfill.

2. APWA Plan 381 for trench backfill above pipe zone.

B. Landscapes: Restore landscaping as indicated and as follows where applicable.

1. Section 32 92 00 “Turf and Grass” for turf and grass cover.

2. Section 32 93 13 “Ground Cover” for other ground cover.

C. Repair public and private facilities damaged by CONTRACTOR.

3.12 SURFACE FINISHING

A. Roadway Trenches and Patches: Restore pavement patches per Section 33 05 25. Provide product and placement indicated in the following standard plans.

1. APWA Plan 255 for bituminous pavement T-patch.

2. APWA Plan 256 for concrete pavement patch.

B. Landscapes: Restore landscaping as indicated and as follows where applicable.

1. Section 32 92 00 “Turf and Grass” for turf and grass cover.

2. Section 32 93 13 “Ground Cover” for other ground cover.

C. Repair public and private facilities damaged by CONTRACTOR.

3.13 COMMISSIONING

A. Before surface finishing, commission pipeline per Section 33 08 00 “Commissioning of Water Utilities.” Provide sizes and types of equipment connections and fittings that match pipe materials when pressure testing system.

B. If paved surfaces must be kept open prior to commissioning, provide temporary paved surfaces.

3.14 CLEANING

A. Remove debris, concrete, or other extraneous material that accumulates in existing piping or structures.

B. Clean all pipelines after testing. Do not flush sand, gravel, concrete, debris or other materials into existing piping systems.

3.15 FIELD QUALITY CONTROL

A. Inspections: OWNER will engage a qualified independent testing and inspecting agency to inspect field-assembled components and connections and prepare test reports.

B. Leakage Testing: Perform leakage testing of completed piping systems. Do not encase, cover, or put piping systems into service until test results are satisfactory.

C. Repair or remove and replace components of drainage systems where test results indicate that they do not comply with specified requirements.

D. Re-test repaired and replaced components of drainage systems to demonstrate compliance.

3.16 MAINTENANCE

A. Regular inspection and maintenance is crucial to ensure the optimal performance and longevity of the drainage system. Develop and implement a routine maintenance program, in accordance with manufacturer's guidelines, to ensure system integrity and performance.

B. Inspect the system semi-annually and after heavy rain events. Include inspection for and removal of debris buildup, damage, or other issues that could affect system performance.

3.17 DOCUMENTATION

A. Submit test reports, warranties, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of the installed drainage system.

END OF SECTION

SECTION 33 52 16

GAS HYDROCARBON PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes all natural gas piping as indicated on the plumbing plans, diagrams and details:

1. Service entrance natural gas piping below ground, settlement joint with vault, and gas piping to gas meters above ground provided and installed by others.
2. Natural gas piping above grade as noted on natural gas piping diagrams.
3. Piping specialties.
4. Seismic expansion loops.
5. Piping and tubing joining materials.
6. Valves.
7. Natural gas pressure regulators other than provided with gas meters.
8. Concrete bases for gas meter sets if required by others.
9. Painting of all exterior natural gas piping above ground downstream of gas meter.

1.2 RELATED SECTIONS

03 30 00 “Cast in Place Concrete”

08 31 13 “Access Doors and Frames”

09 91 26 “Interior Painting”

33 05 20 “Backfilling Trenches”

1.3 REFERENCES

A. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Comply with the following Standards:

1. American National Standards Institute: ANSI

2. American Society of Mechanical Engineers: ASME
3. American Society for Testing and Materials: ASTM
4. American Welding Society: AWS
5. Manufacturers Standardization Society of Valve and Fitting Industry: MSS
6. National Fire Protection Association: NFPA
7. Underwriters Laboratories Inc.: U.L.
8. American Gas Association: AGA

1.4 SUBMITTALS

A. Action Submittals:

1. Piping Matrix: Provide a matrix listing, for natural gas piping systems, and pipe size, the piping material, fitting material and joining method. Product data will not be reviewed without an approved Piping Matrix.
2. Product Data: For each type of the following:
    a. Steel pipe and fittings.
        1) Identify country of origin. Provide mill certification for pipes.
    b. Joining materials.
    c. Dielectric fittings.
    d. Earthquake shut-off valves.
    e. Piping specialties.
    f. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
    g. Pressure regulators. Indicate pressure ratings and capacities.
    h. Pipe supports, interior and exterior.
    i. Exterior pipe paint color.
3. Performance Based Design Submittal:
    a. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
    b. Locations of and details for penetration and firestopping for fire- rated wall and floor and ceiling assemblies.

4. Piping Support, Vibration Control and Seismic Bracing Shop Drawings:

    a. Submit plans, sections, details, schedules and other information necessary to describe piping, valves, specialties, hangers, supports, vibration control, thermal expansion control and seismic bracing for all natural gas piping systems. Shop drawings shall indicate location of all attachments to the building structure. Each attachment point shall identify the horizontal and vertical loads imposed on the building.

    b. Submit an electronic CAD- file in format able to be scaled and combined with other similar files of the bracing, hanging, expansion compensation, anchoring point loads. All point loads shall be represented including magnitude, direction, type (dead, live, seismic, expansion, etc.) and be keyed to the method of attachment details.

5. LEED Submittals:

    a. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

B. Informational Submittals:

1. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

2. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

3. Welding certificates.

4. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Trade Contractor’s Quality Assurance:

1. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

2. Electrical Components, Devices, and Accessories: Listed and labeled as defined, by a Nationally Recognized Testing Laboratory.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 DEFINITIONS

A. "Piping" includes, in addition to pipe, all fittings, flanges, valves, hangers, and other accessories and devices related to such piping.

B. "Wiring" includes in addition to conductors, all raceway, conduit, fittings, boxes, switches, hangers and other accessories related to such wiring.

C. Above Finished Floor: Inside building within a zone usually considered at ±6-inches above floor finish.

D. Above Finished Ceiling: Inside building within a zone usually considered at ±6-inches above ceiling finish.

E. Below Slab: Located in ceiling space of floor below.

F. Concealed: Inside building, above grade, above suspended ceilings, shafts, chases or embedded in construction. In general, any item not visible or directly accessible.

G. Connect: Complete hook-up of item with required services, including all adapters, fittings, valves, devices and components.

H. Exposed: Either visible or subject to mechanical or weather damage, indoors or outdoors, including areas such as mechanical and storage rooms, loading docks and chases. In general, any item that is directly accessible without moving panels, walls, ceiling or other parts of the structure commonly used as reference to surface mounted piping, and similar.

I. Provide: To furnish and install, complete and ready for intended use.

J. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.

K. Install: Includes unloading, unpacking, assembling, erecting, installation, applying finishing, protecting, cleaning and similar operations at project site as required to complete items of work furnished.

L. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the CONTRACTOR as “equivalent”, substitution requests must be submitted to ENGINEER for consideration, in accordance with Division 01, General Requirements and approved by the ENGINEER prior to submitting bids for substituted items.

M. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, OWNER’s insurance underwriter, OWNER’s representative and other reviewing entity whose approval is required to obtain systems acceptance.

N. OWNER’s Authorized Representative (OAR): Defined as the person or persons authorized by the Utah Transit Authority (UTA) to act for or on behalf of the OWNER with respect to the particular subject matter.

1.8 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

2. Service Regulators: 65 psig minimum unless otherwise indicated.

B. Performance Based Design: ENGINEER supports, seismic restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

C. Protect stored PE pipes and valves from direct sunlight.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided if required.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 08 31 13 - Access Doors and Frames.

C. Point of Connection/Interface with Natural Gas Utility Provider: Division 22 CONTRACTOR shall coordinate the natural gas provider all points of connection and scope of work prior to commencing any work.

D. Point of Connection/Interface with Civil Site Utility Services: Building incoming natural gas work to a point as indicated on the Plumbing Drawings.

E. Point of Connection / Interface with Mechanical Drawings: Natural gas connections to radiant heating systems as indicated on the Mechanical and Plumbing Plans, Details and Piping Diagrams and as required by code and per the manufacturer (may not be shown on the drawings and diagrams). Coordinate and review all POC’s and any special valves and devices required prior to start of any work.

1.11 WARRANTY

A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Contracting and Procurement Requirements, Division 01, and individual Division 22, Plumbing Sections.

B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty in Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.12 LEED REQUIREMENTS

A. Project seeks LEED Gold Certified, V3.0 status, as outlined by the United States Green Building Council (www.usgbc.org).

B. Obtain list of credits sought by project. Be familiar with requirements for credits. See Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for requirements.

C. Provide materials and services as outlined in appropriate LEED Reference Guide.

D. Provide documentation as outlined in appropriate LEED Reference Guide.

E. Coordinate start-up, testing, training and installation with Commissioning Agent as required to meet commissioning requirements.

F. Provide adequate schedule for construction activities.

PART 2 - PRODUCTS

2.1 NATURAL GAS PIPING (BELOW GROUND)

A. Polyethylene Pipe: High density polyethylene pipe and fittings in accordance with ASTM D2513; ASTM D3350 and listed with Plastics Pipe Institute (PPI) listed material (TR-4), Grades 2306, 3306 and 3408.

1. Piping Manufacturers:

a. Driscopipe 8100-DRII Series.

b. J.M Eagle HDPE.

2. Fittings: PE 2406 butt-fused only.

3. Joints: PE 2406 butt fused only.

2.2 NATURAL GAS PIPING (ABOVE GROUND)

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.

2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.

3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

a. Material Group: 1.1.

b. End Connections: Threaded or butt welding to match pipe.

c. Lapped Face: Not permitted underground.

d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.

e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Joints: Welded pipe.

B. Refer to Articles Part 3 of this Section for pipe schedules.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.

2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.

3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.

4. Corrugated stainless-steel tubing with polymer coating.

5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).

6. End Fittings: Zinc-coated steel.

7. Threaded Ends: Comply with ASME B1.20.1.

8. Maximum Length: 72 inches.

B. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 inches and smaller; flanged ends for NPS 2- 1/2 inches and larger.

3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.5 MANUAL GAS SHUTOFF VALVES INSIDE BUILDING

A. General Requirements for Metallic Valves, NPS 2 inches and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.

2. Threaded Ends: Comply with ASME B1.20.1.

3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.

4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.

6. Service Mark: Valves 1-1/4 inches to NPS 2 inches shall have initials "WOG" permanently marked on valve body.

7. U.L. Listed and AGA approved.

B. General Requirements for Metallic Valves, NPS 2-1/2 inches and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.

2. Flanged Ends: Comply with ASME B16.5 for steel flanges.

3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. Ball Valves:

1. On local branches 3-inches and smaller, provide three piece full port wafer-type ball valve with bronze boby, ball stem, Teflon seats and lever handles, 300 psig wog.

2. Manufacturer:
    a. Contromatics.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers:
    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Nibco.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 inch and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.
1. Manufacturers:
    a. Hammond
    b. Lee Brass Company
    c. NIBCO
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.

6. Pressure Class: 125 psig.

7. Listing: Valves NPS 1 inch and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers:

a. McDonald, A. Y. Mfg. Co.

b. Mueller Co.; Gas Products Div.

c. Xomox Corporation.

2. Body: Cast iron, complying with ASTM A 126, Class B.

3. Plug: Bronze or nickel-plated cast iron.

4. Seat: Coated with thermoplastic.

5. Stem Seal: Compatible with natural gas.

6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

7. Operator: Square head or lug type with tamperproof feature where indicated.

8. Pressure Class: 125 psig.

9. Listing: Valves NPS 1 inch and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers:

a. Koso Model 313

b. Pacific Seismic Products, Inc.

c. Quake Defense, Inc.

d. Strand Earthquake

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.

3. Maximum Operating Pressure: 7 psig.
4. Cast-aluminum body with stainless-steel internal parts.
5. Nitrile-rubber, reset-stem o-ring seal.
6. Valve position, open or closed, indicator.
7. Composition valve seat with clapper held by spring or magnet locking mechanism.
8. Level indicator.
9. End Connections: Threaded for valves NPS 2 inches and smaller; flanged for valves NPS 2-1/2 inches and larger.
10. Salt Lake City approved.

2.7 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 inches and smaller; flanged for regulators NPS 2-1/2 inches and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers:
   a. Actaris.
   b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   c. Invensys.
   d. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.

7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.

8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.

9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.

10. Overpressure Protection Device: Factory mounted on pressure regulator.

11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

12. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers:

a. Actaris.

b. Eclipse Combustion, Inc.

c. Fisher Control Valves and Regulators; Division of Emerson Process Management.

d. Invensys.

e. Maxitrol Company.

f. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.

3. Springs: Zinc-plated steel; interchangeable.

4. Diaphragm Plate: Zinc-plated steel.

5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.

6. Orifice: Aluminum; interchangeable.

7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.

8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.

9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.

10. Overpressure Protection Device: Factory mounted on pressure regulator.

11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

12. Maximum Inlet Pressure: 5 psig.

2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

B. For all indoor piping identification add gas pressure to pipe identification, refer to Section 22 05 55, Part 3, Service Abbreviations.

2.9 SEISMIC EXPANSION LOOPS

A. General:

1. Provide flexible hose expansion loop(s) as indicated on the contract drawings or as required to accommodate any thermal expansion, contraction or seismic movement of the natural gas cooking waste oil piping system.

2. Flexible hose expansion loops shall be manufactured complete with two parallel sections of corrugated metal house, compatible braid, 180 degree return bend, with inlet and outlet connections. Field fabricated loops shall not be acceptable.

3. Flexible loops shall be capable of movement in the ±X, ±Y, and ±Z planes.

4. Flexible hose expansion loops shall impart no thrust loads to system support, anchors or building structure.

5. Natural gas flexible expansion loops shall be CSA / AGA certified.

6. All flexible hose expansion loops shall be manufactured in accordance with the documented manufacturers weld procedure specifications. The procedure qualification record shall be used to document the execution of this procedure and shall follow the general “guidelines” of ASME Section IX. Each individual welder shall conform to the in-house procedure qualification record and be qualified prior to each production lot. The testing of each individual welder shall be documented in a welding procedure qualification record.

B. Products: Flexible hose expansion loops shall be as follows:

1. Metraloop® as manufactured by The Metraflex Company®, Chicago, IL.

2. Corrugated Hose: Series 304 Stainless steel.

3. Fittings Materials of construction and end fitting type shall be consistent with pipe material and equipment/ pipe connection fittings.

4. Flexible hose expansion loops shall have a factory supplied, hanger / support lug located at the bottom of the 180deg return.

5. Flexible hose expansion loop(s) shall be furnished with a plugged FPT to be used for a drain or air release vent.

Loop Pipe Size	FPT Size
1” – 6”	3/8”

6. Flexible hose expansion loop(s) shall be rated with an operating pressure in accordance with manufacturers requirements. The operating pressure shall be based on burst pressure with a 4 to 1 safety factor and double braid.

C. Installation:

1. Install and guide per manufacturers’ installation instructions and Mechanical Contractors Association of America “Guidelines for Quality Piping Installations”.

2. Flexible hose expansion loop return fitting shall be supported to allow movement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54, to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 for prevention of accidental ignition.

3.3 EXTERIOR PIPING INSTALLATION

A. Comply with NFPA 54 and International Plumbing Code for installation and purging of natural- gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas meters and piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Division 22 CONTRACTOR shall coordinate with natural gas provider for all points of connection, meter locations prior to commencing work.

D. Paint all exposed natural gas piping per article ”Painting” in Part 3 of this Section. Prepare surface of galvanized black steel piping per manufacturer’s recommendation prior to painting.

3.4 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and International Plumbing Code for installation and purging of natural- gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install piping plumb and parallel/perpendicular to building lines.

H. Locate valves for easy access.

I. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

J. Hold piping as tight to structure as possible. Install all piping parallel and perpendicular to building elements in a neat, workmanlike manner.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service- meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

R. Concealed Location Installations:

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

2. Prohibited Locations:

a. Do not install natural-gas piping below floor slabs in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

b. Do not install natural-gas piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

V. Do not use natural-gas piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 22 05 20 - Meters and Gages for Plumbing Piping."

Y. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 16 - Sleeves and Sleeve Seals for Plumbing Piping."

Z. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 16 - Sleeves and Sleeve Seals for Plumbing Piping."

AA. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 - Escutcheons for Plumbing Piping."

BB. Install seismic expansion loops per manufacturer's recommendation.

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

C. Install earthquake valves aboveground outside buildings according to listing.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.

2. Cut threads full and clean using sharp dies.

3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.

4. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.

2. Bevel plain ends of steel pipe.

3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.7 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 45 "Vibration and Seismic Controls for Plumbing, Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Section 230530 "Hangers and Supports for Plumbing Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 inch and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch .

2. NPS 1-1/4 inch: Maximum span, 108 inches; minimum rod size, 3/8 inch .

3. NPS 1-1/2 and NPS 2 inches: Maximum span, 108 inches; minimum rod size, 3/8 inch.

4. NPS 2-1/2 to NPS 3-1/2 inches: Maximum span, 10 feet ; minimum rod size, 1/2 inch.

5. NPS 4 inches and Larger: Maximum span, 10 feet minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Section 23 05 55 "Identification for Plumbing Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Section 09 91 26 "Interior Painting" for painting interior natural- gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.

b. Intermediate Coat: Exterior alkyd enamel matching topcoat.

c. Topcoat: Exterior alkyd enamel (gloss).

d. Color: Gray or match gas meter color.

C. Paint exposed, interior metal piping, valves, service regulators, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Alkyd anticorrosive metal primer.

b. Intermediate Coat: Interior latex matching topcoat.

c. Topcoat: Interior latex (semi-gloss).

d. Color: Gray.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 CONCRETE BASES IF REQUIRED BY GAS PROVIDER

A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 03 30 00 “Cast in Place Concrete.”

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and International Plumbing Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.13 DEMONSTRATION

A. Engage a factory-authorized service representative to train OWNER's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 1.0 PSIG

A. Aboveground, piping 2 inch and smaller shall be as follows:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, piping 2-1/2” and larger shall be as follows:

1. Steel pipe with wrought-steel fittings and welded joints.

2. steel welding fittings and welded joints with flanges at all values and connection points.

3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 inch and smaller at service meter shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

2. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 inch and larger at service meter shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

2. Bronze plug valve.

3. Cast-iron, non-lubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 inch and smaller shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

2. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 inch and larger shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

2. Bronze plug valve.

3. Cast-iron, lubricated plug valve.

E. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.

2. Two-piece, full-port, bronze ball valves with bronze trim.

3. Bronze plug valve.

3.16 TESTING

A. General: Provide labor and test equipment including test pumps, gages, instruments and other equipment required. Use test quality pressure gages, instruments and other equipment required. Use test quality pressure gages with range of approximately twice test pressure. Use calibrated gages and instruments. Test results and compliance shall be submitted as part of the Operation and Maintenance Manuals.

B. Piping:

1. General: Remove from systems, during testing, equipment which would be damaged by test pressure. Replace removed equipment after testing. Systems may be tested in sections as work progresses; however, any previously tested portion shall become a part of any later test of composite system. Correct leaks by remaking joints with new material; make shift remedies will not be permitted. Test time accrues only while full test pressure is on system. Test before backfilling, concealing, insulating or making connections to potable water system.

2. Test Schedule: Test each section of systems at one and one-half (1-1/2) times the maximum working pressure of that section, but at not less than scheduled test pressure. Obtain maximum working pressures from IPC or NFPA 54 if not indicated on Drawings. Unless indicated otherwise, scheduled tolerance is "no pressure loss", except that due to temperature change, in 24 hour period.

Test Schedule			
System	Test Medium	Test Pressure	Tolerance
Natural Gas	Air or Nitrogen	1-1/2 times max. working pressure	No leaks – 4 hours

END OF SECTION

SECTION 33 71 73

ELECTRICAL UTILITY SERVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Under ground and above ground electrical service systems.

1.2 RELATED SECTIONS

01 71 13 “Field Engineering”

01 55 26 “Traffic Control”

03 30 00 “Cast in Place Concrete”

26 05 13 “Conductors and Cables”

26 05 33 “Raceways and Boxes for Electrical Systems”

31 05 13 “Common Fill”

31 23 16 “Excavation”

31 23 26 “Compaction”

32 11 23 “Aggregate Base Course”

1.3 REFERENCES

A. NFPA Standards:

1. 70 National Electric Code.

1.4 SUBMITTALS

A. Product Data: Manufacturer’s technical data for electrical components, including dimensions, materials, and performance characteristics.

B. Shop Drawings: Include plans, elevations, sections, details of components, and attachments to other work.

C. Test Reports: Certified test reports demonstrating compliance with specified standards.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer must have a minimum of 5 years' experience producing similar products and be certified to relevant standards.

B. Installer Qualifications: Installer must have a minimum of 3 years' experience performing similar work.

C. Pre-Installation Meetings: Conduct a pre-installation meeting to review project requirements, installation procedures, and coordination with other trades.

1.6 ACCEPTANCE

A. Not Applicable.

1.7 PERFORMANCE REQUIREMENTS

A. Conform to:

1. NFPA 70.

2. Electrical authority having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Conduit: Section 26 05 33 "Raceways and Boxes for Electrical Systems."

B. Concrete: Class 3000 minimum, Section 03 30 00 "Cast in Place Concrete", with No. 67 aggregate or larger and dye additive to give permanent red color.

C. Conductors: Section 26 05 13 "Conductors and Cables" or required by NFPA 70.

D. Cable Lugs: Suitable for application.

E. Duct Spacers: Fabricated plastic, UL approved.

F. Meter Sockets: Comply with requirements of power utility company.

G. Metering: Sized to capacity of main switch or buss as applicable.

2.2 BACKFILL

A. Sand fill, Section 31 05 13 "Common Fill."

B. Aggregate base course, Section 32 11 23 "Aggregate Base Courses."

2.3 INSULATORS AND ACCESSORIES

A. Provide as required by NFPA 70 and acceptable to power utility company.

2.4 WARNING TAPE

A. Provide non-detectable, colored warning tape suitable for direct burial over utility lines.

PART 3 - EXECUTION

3.1 PREPARATION

A. Implement traffic control plan requirements, Section 01 55 26 “Traffic Control.”

B. Coordinate utility locations, Section 01 71 13 “Field Engineering.”

C. Excavation, Section 31 23 16 “Excavation.”

3.2 INSTALLATION

A. Provide adaptation from conduit to PVC duct.

B. Slope service to drainage point.

C. Terminate service conduit in main panel and transformer with grounding bushings. Make suitable ground connection from bushing to distribution center ground bus.

D. Install on undisturbed soil where possible. Comply with backfill and compaction requirements of Section 31 23 26 “Compaction.”

3.3 DUCTBANK

A. Place concrete so voids around ducts are filled.

B. Provide minimum concrete thickness between ducts of two (2) inches.

C. Adjust final slopes on site to coordinate with existing utilities.

D. Install drain assembly with saddle cutouts for each conduit. Tape drain assembly to each conduit to prevent entrance of concrète. Band drain assembly with 1/2 inch stainless steel straps to conduit assembly to prevent mechanical displacement. Connect to piping drain.

E. After installation, clean and swab ducts.

F. Install galvanized steel pull wires in spare ducts. Cap spare ducts.

3.4 DIRECT BURIAL

A. Level trench with three (3) inches minimum layer of sand. Cover conductors with six (6) inches layer of sand. Provide physical protection acceptable to electrical authority having jurisdiction.

3.5 SERVICE INSTALLATION

A. Provide duct bank from property line or supply authority's pole to transformer or building as required.

B. Coordinate with utility company to install conductor from source to meter. Coordinate trenching, supplying and placing of sand and backfilling with power utility company.

3.6 FIELD QUALITY CONTROL

A. Inspect, splice and test continuity for all special telemetry cables before backfilling trenches.

B. Perform insulation resistance tests on each conductor with respect to ground and adjacent conductors. Provide a written report indicating results.

C. Perform voltage and continuity tests to verify proper connections.

D. Conduct operational tests on transformers, switchgear, and other equipment to ensure proper functioning.

E. Perform inspections at various stages of installation to ensure compliance with project specifications and industry standards.

F. Document all test results and inspection findings.

G. Obtain final approval and acceptance of the installed systems.

3.7 INSTALLATION - WARNING TAPE

A. Install warning tape directly above utility line at a depth to ensure future diggers will encounter the warning tape before the utility.

3.8 DAMAGE REPAIR

A. Repair or replace components of existing utilities that are damaged by construction activities, to the satisfaction of the utility owner.

3.9 COORDINATION WITH OTHER UTILITIES

A. Coordinate placement of electrical utilities with other utilities to avoid conflicts and to ensure proper spacing between utilities as required by NFPA 70 and local codes.

3.10 DOCUMENTATION

A. Submit test reports, installation records, and maintenance instructions.

B. Provide final as-built drawings showing the location and details of installed systems.

END OF SECTION

Division 34 – Transportation

Division 34 – Transportation
Section 11 – Light Rail Transit (LRT)

SECTION 34 11 23

LRT – SPECIAL TRACKWORK

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. This Specification defines the requirements for the design, detailing, manufacturing, fabricating, furnishing and delivery of pre-curved rail and restraining rail.

2. Work under this Section covers furnishing all labor, materials, and equipment for the manufacture, testing, indicating and shipping of restraining rail, restraining rail joints, separator blocks, bolt assemblies and associated hardware as required to provide a complete installation.

3. The restraining rail shall consist of a standard 115RE tee rail section modified as defined in this section for use as a restraining rail, added to and pre-curved to match the inside running rail, in curved track with radius less than or equal to 300 ft.

4. Precurved rail for curves less than or equal to 300 ft. radii inclusive restraining rail assemblies.

5. CONTRACTOR shall supply all rail for restraining rail manufacturing according to Section 34 11 34 “Standard and High Strength Rail.”

6. Metal housings for electrical signal boxes.

B. Measurement and Payment:

1. No separate measurement and payment will be made for the work described in this section.

1.2 RELATED SECTIONS

01 33 00 - Submittal Procedures

01 45 00 - Quality Control

34 11 32 - Ballast

34 11 34 - Standard and High Strength Rail

34 11 31 - Subballast

34 11 27 - Ballasted Track Construction

34 11 25 - Embedded Track Construction

1.3 REFERENCES

A. The following Codes, Regulations, Reference Standards and Specifications apply to the work.

B. Special trackwork shall be new and manufactured, fabricated, and inspected in accordance with the following current standards, except as modified herein.

C. Association of American Railroads (AAR)

1. Part 14.5 Signal Manual

D. American Railway Engineering and Maintenance of Way Association (AREMA)

1. Chapter 4 - Manual for Railway Engineering

2. Manual for Railway Engineering, and Portfolio of Trackwork Plans

E. American Society of Testing and Materials (ASTM) Standards:

1. E10-07a - Standard Test Method for Brinell Hardness of Metallic Materials

2. A27/A27M-05 - Standard Specification for Steel Castings, Carbon, for General Application

3. A36/A36M-05 - Standard Specification for Carbon Structural Steel

4. A47/A47M-99(2004) - Standard Specification for Ferrite Malleable Iron Castings

5. A128/A128M-93(2007) - Standard Specification for Steel Castings, Austenitic Manganese

6. A325-07 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

7. A490-08a - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength

8. A536-84(2004) - Standard Specification for Ductile Iron Castings

9. A588/A588M-05 - Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 Mpa) Minimum Yield Point to 4 in. (100 mm) Thick

10. E10-07a - Standard Method of Brinell Hardness for Metallic Materials

11. A370-07b - Standard Test Methods and Definitions for Mechanical Testing of Steel Products

12. A449-07b - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

13. B633-07 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

14. D149-97a(2004) - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

15. D217-02(2007) - Standard Test Methods for Cone Penetration of Lubricating Grease

16. D257-07 - Standard Test Methods for DC Resistance or Conductance of Insulating Materials

17. D395-03 - Standard Test Methods for Rubber Property- Compression Set

18. D429-03e1 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates

19. D445-06 - Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids

20. D471-06 - Standard Test Method for Rubber Property – Effect of Liquids

21. D543-06 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents

22. D566-02 - Standard Test Method for Dropping Point of Lubricating Grease

23. D575-91(2007) - Standard Test Methods for Rubber Properties in Compression

24. D751-06 - Standard Test Methods for Coated Fabrics

25. D792-00 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

26. D814-95(2005) - Standard Test Method for Rubber Property – Vapor Transmission of Volatile Liquids

27. D1004-07 - Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting

28. D5992-96 (2006) e1 - Standard Guide for Dynamic Testing of Vulcanized Rubber and Rubber-Like Materials Using Vibratory Methods

29. D2240-05 - Standard Test Method for Rubber Property-Durometer Hardness

30. D4551-96(2001) - Standard Specification for Poly (Vinyl Chloride) Plastic Flexible Concealed Water-Containment Membranes

31. D4833-07 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

F. American National Standards Institute (ANSI)

1. B18.2.1-1996 - Square and Hex Bolts and Screws

2. B18.21.1-1999 - Lock Washers

3. B18.22.1-1965 (R2003) - Plain Washers

G. National Electric Manufacturers Association (NEMA)

1. LI-1-1998 - Industrial Laminated Thermosetting Products

H. FTMS

1. 191 - Method 5102

1.4 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein.

B. Submit installation procedures for glued insulated rail joints.

C. Submit shop drawings for pre-curved head hardened rail for each location.

D. Submit shop drawings for restraining rail and mainline track assemblies.

E. Submit shop drawings for electrical signal boxes.

F. A list of proposed fabricators and of all components within 30 days of notice to proceed. Subsequent changes in proposed suppliers shall be submitted as they occur.

G. A detailed installation plan, including shop drawings for each segment of restraining rail and its associated running rail.

H. A detailed description of the method of fabrication for the separator block assemblies.

I. A detailed description of other components used in the restraining rail assemblies including but not limited to shims, bolts, washers, nuts, etc.

J. Marking scheme for restraining rail identification for installation.

K. Submit the method of handling and shipping for review and acceptance at least four weeks before shipping of the restraining rail and accompanying hardware.

1.5 QUALITY ASSURANCE

A. Fabricate pre-curved rail and restraining rail as shown on Plans and in accordance with the requirements of the AREMA Manual for Railway Engineering.

B. The products and material incorporated into the work shall be subject to inspection by UTA, at the CONTRACTOR’s and Subcontractor’s facilities, place of manufacture, the shipping point, and at the shipping destination. Inspection by the UTA representative will be performed in such a manner as not to unduly delay the work.

C. Whether or not a UTA representative inspects any materials, responsibility for defects or other failures to the meet the contract requirements is the CONTRACTOR's. Such inspection shall not be considered as a guarantee of acceptance of any material.

1.6 TOLERANCES

A. All fabrication tolerances shall conform with the track gauge of 4'- 8 ½", +/− 1/16", and a horizontal and vertical cross level tolerance of 1/16 inch measured in 6 foot chords.

B. All component and fit tolerances shall meet the applicable requirements of AREMA recommended practices.

1.7 DELIVERY, HANDLING AND STORAGE

A. Restraining rail shall be stacked and banded for shipment according to normal practice and grouped per each track curve. Separator blocks shall be palletized. Small loose parts, such as bolts, washers and nuts shall be placed in secure shipping boxes and kegs that are marked with specific track curve identification.

B. The restraining rail shall be lifted and handled with care to avoid damage. Restraining rail shall be loaded with adequate wood strips between the tiers of rail to prevent damage in transit.

PART 2 – PRODUCTS

2.1 RAIL

A. Precurved rail for curves less than or equal to 300 ft. radii shall be high strength rail in accordance with Section 34 11 34 "Standard and High Strength Rail", with a minimum Brinell Hardness of 370 BN.

B. Rails shall be cut square and clean by means of rail saws, shears or abrasive cutting wheels in accordance with the applicable current AREMA recommended practices.

C. Rail ends shall be drilled for standard 6-hole joint bars in accordance with the current AREMA Manual for Railway Engineering, Rail Drillings, Bar Punchings, and Track Bolts (Chapter 4, Section 1.3). Holes drilled in the rails shall be 1-⅛ inches in diameter and shall be reamed or ground to remove all sharp edges only at required locations such as restraining rail locations or for temporary assembly locations.

D. Precurved rail for curves less than or equal to 300 ft. radii shall be pre-curved in the shop by either gag press or roller bending methods. The rails shall be curved to true radius throughout the designated curve length and shall not exhibit visible kinks or tangents.

E. CONTRACTOR shall furnish all rail needed for precurved rail within the limits indicated on Contract drawings.

2.2 RESTRAINING RAIL

A. The restraining rail shall consist of standard 115RE Tee rail section as indicated in the Contract drawings with part of the base cut off. Base planning shall provide a minimum clearance of one inch between rail base.

1. Section Lengths:

a. Restraining rail shall be provided in the longest allowable pre-curved sections. All main line track having a center line radius of less than or equal to 300 feet shall have restraining rail added to the inside running rail as indicated on drawings and as specified in this section.

b. The minimum length of bolted restraining rail, except end approach sections, shall be 21 feet. The maximum length for shipping shall be 39ft.

2. Fabrication:

a. Restraining Rail shall be designed, fabricated, and shop assembled with the matching inside running rail, as required by this Section.

b. All restraining rails shall be drilled at ends for joint bars and reinforcing bar. Joints in restraining rails shall be offset longitudinally from joints in the running rail by a minimum of 5 feet except where they connect to frog or crossing castings. Restraining rails shall not be welded to adjoining rails.

c. The CONTRACTOR shall prepare shop drawings for restraining rail to show complete details of the location of rail fasteners beneath the assembled restraining rail and running rail. The shop drawings shall show that the spacing of restraining rail separator blocks will not create interference between the separator block bolts and the spring clips on the rail fastener assemblies. Running rails and restraining rails shall be furnished in lengths such that separator blocks will not be located within 6 inches of a field weld in the running rail and that field welded joints in the running rail will not be located at rail fastener locations.

d. All separator and end blocks shall be bolted with heat treated bolts with lock nuts and spring washers. Restraining rail and matching pre-curved running rail shall be shop drilled for separator blocks. Drilled holes shall be ground to remove all sharp edges. Upset rail branding shall be ground flush in all separator block areas.

e. Rails shall be machined, cut and drilled but not flame or torch cut.

2.3 RESTRAINING RAIL SEPARATOR BLOCKS AND INNER AND OUTER HEADLOCKS

A. New Grade N-3 cast steel in accordance with the AREMA Specifications for Special Trackwork. Carbon content of castings shall not exceed 0.30 percent. Fabricate end blocks and separator blocks of machined carbon steel or malleable or Grade 50 ductile iron castings, as shown and in accordance with AREMA Specs. Separator blocks at joints in either the running rail or the restraining rail shall extend the full length of the joint bar.

2.4 MOUNTING HARDWARE AND OTHER COMPONENTS

A. Restraining rail mounting bolts shall be square head with a hole for a cotter pin. Nuts shall be castellated hex nuts.

B. Joints in restraining rail shall be standard 115RE joint bars on the side of the restraining rail closest to the centerline of track and rolled steel “D” bar on the side facing the running rail.

C. Bolts shall be ASTM A325, ASTM A449, SAE Grade 5 or equivalent. Threads shall be UNC, 2A and 2B. Bolts shall be of the diameters and lengths as developed by the CONTRACTOR and meeting the following additional requirements:

1. Bolts for standard joints shall be square head with hex nuts and spring washers. Spring washers shall be in accordance with the AREMA Manual, Chapter 4, Part 3, Specification for Spring Washers Section 3.6.

D. Additional requirements for insulated joints:

1. The electrical properties of the completed insulated joint shall meet the requirements of the Association of American Railroads (AAR) Signal Manual, Part 14.5. Refer to section 34 11 94 for insulated joint requirements.

2.5 PRE-CURVED RAILS

A. Pre-curve rail used for track curves having equal or less than 300-foot radius for continuously welded rail (CWR).

B. Pre-curved rail may be cropped at 36-foot lengths to allow for exact curve bending radii or spiral transition.

C. All rails shall be straight before pre-curving.

D. Precurved rail tolerances to be achieved are as follows:

1. Uniformly curved rail, such that the deviation of the measured interior mid ordinate offset from the theoretical offset, measured at any point, is within the following:

a. Ten foot chord: within 1/8 inch

b. Fifteen foot chord: within ¼ inch

c. Thirty foot chord: within 1 inch

2. Precurved rail bases shall bear fully on canted tie plates or rail fasteners when laid out on a flat surface. Camber rails vertically prior to making horizontal bends when necessary to meet this requirement.

3. Distortion in pre-curved rail base that prevents full bearing on canted plates will not be acceptable.

E. Curved rails shall be pre-curved in the shop by either gag press or roller bending methods.

F. Identify pre-curved rail with painted identity numbering per approved Shop Drawing code at the end of each rail, and paint identity numbers so that they are visible from both the top and the side of the rails.

G. Fabricate all pre-curved rail from the rail furnished by the CONTRACTOR.

H. Refer to Specification section 34 11 34 T “Standard and High Strength Rail” & 34 11 27 T “Ballasted Track Construction.”

PART 3 – EXECUTION

3.1 GENERAL

A. An installation plan shall be developed for each curve prior to fabrication of restraining rail.

B. The restraining rail lengths shall be precut in the shop to exact length for each curve.

C. End flares for the beginning and end pieces of restraining rail for each curve shall be milled in the shop before delivery to the site. Fabrication of end flares in the field is prohibited.

D. Rail shall be laid out for each location in accordance with the track geometry and fabricated with the adjacent running rail to provide fastening connections at correct locations.

3.2 SPECIAL TRACKWORK CONSTRUCTION

A. Subballast: Place sub-ballast as specified in SECTION 34 11 31 – SUBBALLAST, conforming to recommended practices in AREMA Chapter 1, Section 2.1.

1. Geotextile Fabric: Place geotextile fabric under all Special Trackwork. Fabric shall extend the entire interface zone between ballast and subballast. Fabric will extend 20 feet before point of switch and 10 feet after last long tie or as directed in the Contract Drawings.

B. Ballast: Place ballast as specified in SECTION 34 11 32 – BALLAST, conforming to recommended practices in AREMA Chapter 1, Part 2.

C. Switch Ties:

2. For wood ties in mainline turnouts, pre-bore 9/16-inch diameter holes in timber tie for ¾-inch lag screws with electrically isolated bushings.

3. For concrete ties in mainline turnouts, provide insulated fastening devices in accordance with manufacturer’s layout drawings.

4. Space and line switch ties in accordance with manufacturer’s layout drawings for the particular type of turnout or crossover being installed.

D. Plates and Pads for wood tie construction: Locate and secure all special and standard tie plates and tie pads as shown on the manufacturer’s drawings. Note that mainline and turnout plates are affixed to wooden ties with lag screws.

E. Turnout Elements: Assemble and install turnout elements in accordance with manufacturer's drawings and recommended practices as shown in AREMA Portfolio of Track Plans.

F. Surface and Align: Surface and line special trackwork as specified in SECTION 34 11 27 - BALLASTED TRACK CONSTRUCTION, except that switch ties shall be tamped uniformly throughout their entire length.

G. Switch Stands: Install switch stands in accordance with manufacturer's drawings and instructions at all manual switches as identified in Article 3.1.B of this Specification.

3.3 SHOP ASSEMBLY

A. Pre-Curved Rail Assemblies.

1. Provide shop drawings for pre-curved rail lengths by rail sequence number showing the radius for each rail length and its location in the track.

   a. Include the method of marking rails for identification and installation at least 30 days prior to commencement of pre-curving project rolled and approved.

   b. Mark Tangent to Spiral, Spiral to Curve, Curve to Spiral and Spiral to Tangent points where applicable.

2. Shop curved rails shall be per calculated lengths shown on the approved Shop Drawings plus or minus ⅛-inch.

3.4 IDENTIFICATION MARKING

A. Each piece of restraining rail shall be marked to indicate its proposed installed location.

B. Marks shall be in at least two locations on each piece, widely separated, located on the top to be visible after installation.

C. Bundle restraining rail quantities per each specific track curve and tag each bundle with the curve identification number.

3.5 HANDLING AND DELIVERY

A. Except as modified herein, handle, transport and store pre-curved rails and restraining rails in accordance with the current AREMA recommended practices. All rails shall be handled carefully and delivered in open top containers to avoid damage by kinking, bending, nicking, or other potential damage to the rail. Rails shall not be dropped or struck sharply. Handling and delivery shall be in accordance with accepted industry practice.

B. Small loose parts and miscellaneous hardware shall be delivered in secure boxes and kegs, each weighing not more than 80 pounds.

C. All bundles, boxes and kegs shall be clearly marked with the following information:

1. Identification of items contained

2. Supplier's name
3. Delivery date
4. Number of pieces
5. Gross weight

D. Bundle restraining rail quantities per each specific track curve and tag each bundle with the curve identification number.

E. Precurved rails shall be banded in groups and shipped together for each curve with rail head upward, if rails were stored at an off-site location. Each banded group shall be identified with stamped metal tag indicating:

1. The number of banded rail groups per curve.
2. The curve identification.
3. The total number of rails in the curve.

F. Precurved rails shall be wedged and blocked for shipment so as to prevent accidental bending of the rail.

END OF SECTION

SECTION 34 11 23

LRT – SPECIAL TRACKWORK

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. This Specification defines the requirements for the design, detailing, manufacturing, fabricating, furnishing and delivery of pre-curved rail and restraining rail.

2. Work under this Section covers furnishing all labor, materials, and equipment for the manufacture, testing, indicating and shipping of restraining rail, restraining rail joints, separator blocks, bolt assemblies and associated hardware as required to provide a complete installation.

3. The restraining rail shall consist of a standard 115RE tee rail section modified as defined in this section for use as a restraining rail, added to and pre-curved to match the inside running rail, in curved track with radius less than or equal to 300 ft.

4. Precurved rail for curves less than or equal to 300 ft. radii inclusive restraining rail assemblies.

5. CONTRACTOR shall supply all rail for restraining rail manufacturing according to Section 34 11 34 “Standard and High Strength Rail.”

6. Metal housings for electrical signal boxes.

B. Measurement and Payment:

1. No separate measurement and payment will be made for the work described in this section.

1.2 RELATED SECTIONS

01 33 00 - Submittal Procedures

01 45 00 - Quality Control

34 11 32 - Ballast

34 11 34 - Standard and High Strength Rail

34 11 31 - Subballast

34 11 27 - Ballasted Track Construction

34 11 25 - Embedded Track Construction

1.3 REFERENCES

A. The following Codes, Regulations, Reference Standards and Specifications apply to the work.

B. Special trackwork shall be new and manufactured, fabricated, and inspected in accordance with the following current standards, except as modified herein.

C. Association of American Railroads (AAR)

1. Part 14.5 Signal Manual

D. American Railway Engineering and Maintenance of Way Association (AREMA)

1. Chapter 4 - Manual for Railway Engineering

2. Manual for Railway Engineering, and Portfolio of Trackwork Plans

E. American Society of Testing and Materials (ASTM) Standards:

1. E10-07a - Standard Test Method for Brinell Hardness of Metallic Materials

2. A27/A27M-05 - Standard Specification for Steel Castings, Carbon, for General Application

3. A36/A36M-05 - Standard Specification for Carbon Structural Steel

4. A47/A47M-99(2004) - Standard Specification for Ferrite Malleable Iron Castings

5. A128/A128M-93(2007) - Standard Specification for Steel Castings, Austenitic Manganese

6. A325-07 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

7. A490-08a - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength

8. A536-84(2004) - Standard Specification for Ductile Iron Castings

9. A588/A588M-05 - Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 Mpa) Minimum Yield Point to 4 in. (100 mm) Thick

10. E10-07a - Standard Method of Brinell Hardness for Metallic Materials

11. A370-07b - Standard Test Methods and Definitions for Mechanical Testing of Steel Products

12. A449-07b - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

13. B633-07 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

14. D149-97a(2004) - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
15. D217-02(2007) - Standard Test Methods for Cone Penetration of Lubricating Grease
16. D257-07 - Standard Test Methods for DC Resistance or Conductance of Insulating Materials
17. D395-03 - Standard Test Methods for Rubber Property- Compression Set
18. D429-03e1 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates
19. D445-06 - Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids
20. D471-06 - Standard Test Method for Rubber Property – Effect of Liquids
21. D543-06 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
22. D566-02 - Standard Test Method for Dropping Point of Lubricating Grease
23. D575-91(2007) - Standard Test Methods for Rubber Properties in Compression
24. D751-06 - Standard Test Methods for Coated Fabrics
25. D792-00 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
26. D814-95(2005) - Standard Test Method for Rubber Property – Vapor Transmission of Volatile Liquids
27. D1004-07 - Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
28. D5992-96 (2006) e1 - Standard Guide for Dynamic Testing of Vulcanized Rubber and Rubber-Like Materials Using Vibratory Methods
29. D2240-05 - Standard Test Method for Rubber Property-Durometer Hardness
30. D4551-96(2001) - Standard Specification for Poly (Vinyl Chloride) Plastic Flexible Concealed Water-Containment Membranes
31. D4833-07 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

F. American National Standards Institute (ANSI)

1. B18.2.1-1996 - Square and Hex Bolts and Screws

2. B18.21.1-1999 - Lock Washers

3. B18.22.1-1965 (R2003) - Plain Washers

G. National Electric Manufacturers Association (NEMA)

1. LI-1-1998 - Industrial Laminated Thermosetting Products

H. FTMS

1. 191 - Method 5102

1.4 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein.

B. Submit installation procedures for glued insulated rail joints.

C. Submit shop drawings for pre-curved head hardened rail for each location.

D. Submit shop drawings for restraining rail and mainline track assemblies.

E. Submit shop drawings for electrical signal boxes.

F. A list of proposed fabricators and of all components within 30 days of notice to proceed. Subsequent changes in proposed suppliers shall be submitted as they occur.

G. A detailed installation plan, including shop drawings for each segment of restraining rail and its associated running rail.

H. A detailed description of the method of fabrication for the separator block assemblies.

I. A detailed description of other components used in the restraining rail assemblies including but not limited to shims, bolts, washers, nuts, etc.

J. Marking scheme for restraining rail identification for installation.

K. Submit the method of handling and shipping for review and acceptance at least four weeks before shipping of the restraining rail and accompanying hardware.

1.5 QUALITY ASSURANCE

A. Fabricate pre-curved rail and restraining rail as shown on Plans and in accordance with the requirements of the AREMA Manual for Railway Engineering.

B. The products and material incorporated into the work shall be subject to inspection by UTA, at the CONTRACTOR's and Subcontractor's facilities, place of manufacture, the shipping point, and at the shipping destination. Inspection by the UTA representative will be performed in such a manner as not to unduly delay the work.

C. Whether or not a UTA representative inspects any materials, responsibility for defects or other failures to the meet the contract requirements is the CONTRACTOR's. Such inspection shall not be considered as a guarantee of acceptance of any material.

1.6 TOLERANCES

A. All fabrication tolerances shall conform with the track gauge of 4'- 8 ½", +/− 1/16", and a horizontal and vertical cross level tolerance of 1/16 inch measured in 6 foot chords.

B. All component and fit tolerances shall meet the applicable requirements of AREMA recommended practices.

1.7 DELIVERY, HANDLING AND STORAGE

A. Restraining rail shall be stacked and banded for shipment according to normal practice and grouped per each track curve. Separator blocks shall be palletized. Small loose parts, such as bolts, washers and nuts shall be placed in secure shipping boxes and kegs that are marked with specific track curve identification.

B. The restraining rail shall be lifted and handled with care to avoid damage. Restraining rail shall be loaded with adequate wood strips between the tiers of rail to prevent damage in transit.

PART 2 – PRODUCTS

2.1 RAIL

A. Precurved rail for curves less than or equal to 300 ft. radii shall be high strength rail in accordance with Section 34 11 34 "Standard and High Strength Rail", with a minimum Brinell Hardness of 370 BN.

B. Rails shall be cut square and clean by means of rail saws, shears or abrasive cutting wheels in accordance with the applicable current AREMA recommended practices.

C. Rail ends shall be drilled for standard 6-hole joint bars in accordance with the current AREMA Manual for Railway Engineering, Rail Drillings, Bar Punchings, and Track Bolts (Chapter 4, Section 1.3). Holes drilled in the rails shall be 1-⅛ inches in diameter and shall be reamed or ground to remove all sharp edges only at required locations such as restraining rail locations or for temporary assembly locations.

D. Precurved rail for curves less than or equal to 300 ft. radii shall be pre-curved in the shop by either gag press or roller bending methods. The rails shall be curved to true radius throughout the designated curve length and shall not exhibit visible kinks or tangents.

E. CONTRACTOR shall furnish all rail needed for precurved rail within the limits indicated on Contract drawings.

2.2 RESTRAINING RAIL

A. The restraining rail shall consist of standard 115RE Tee rail section as indicated in the Contract drawings with part of the base cut off. Base planning shall provide a minimum clearance of one inch between rail base.

1. Section Lengths:

a. Restraining rail shall be provided in the longest allowable pre-curved sections. All main line track having a center line radius of less than or equal to 300 feet shall have restraining rail added to the inside running rail as indicated on drawings and as specified in this section.

b. The minimum length of bolted restraining rail, except end approach sections, shall be 21 feet. The maximum length for shipping shall be 39ft.

2. Fabrication:

a. Restraining Rail shall be designed, fabricated, and shop assembled with the matching inside running rail, as required by this Section.

Commented [EB1]: Self Reference

b. All restraining rails shall be drilled at ends for joint bars and reinforcing bar. Joints in restraining rails shall be offset longitudinally from joints in the running rail by a minimum of 5 feet except where they connect to frog or crossing castings. Restraining rails shall not be welded to adjoining rails.

c. The CONTRACTOR shall prepare shop drawings for restraining rail to show complete details of the location of rail fasteners beneath the assembled restraining rail and running rail. The shop drawings shall show that the spacing of restraining rail separator blocks will not create interference between the separator block bolts and the spring clips on the rail fastener assemblies. Running rails and restraining rails shall be furnished in lengths such that separator blocks will not be located within 6 inches of a field weld in the running rail and that field welded joints in the running rail will not be located at rail fastener locations.

d. All separator and end blocks shall be bolted with heat treated bolts with lock nuts and spring washers. Restraining rail and matching pre-curved running rail shall be shop drilled for separator blocks. Drilled holes shall be ground to remove all sharp edges. Upset rail branding shall be ground flush in all separator block areas.

e. Rails shall be machined, cut and drilled but not flame or torch cut.

2.3 RESTRAINING RAIL SEPARATOR BLOCKS AND INNER AND OUTER HEADLOCKS

A. New Grade N-3 cast steel in accordance with the AREMA Specifications for Special Trackwork. Carbon content of castings shall not exceed 0.30 percent. Fabricate end blocks and separator blocks of machined carbon steel or malleable or Grade 50 ductile iron castings, as shown and in accordance with AREMA Specs. Separator blocks at joints in either the running rail or the restraining rail shall extend the full length of the joint bar.

2.4 MOUNTING HARDWARE AND OTHER COMPONENTS

A. Restraining rail mounting bolts shall be square head with a hole for a cotter pin. Nuts shall be castellated hex nuts.

B. Joints in restraining rail shall be standard 115RE joint bars on the side of the restraining rail closest to the centerline of track and rolled steel “D” bar on the side facing the running rail.

C. Bolts shall be ASTM A325, ASTM A449, SAE Grade 5 or equivalent. Threads shall be UNC, 2A and 2B. Bolts shall be of the diameters and lengths as developed by the CONTRACTOR and meeting the following additional requirements:

1. Bolts for standard joints shall be square head with hex nuts and spring washers. Spring washers shall be in accordance with the AREMA Manual, Chapter 4, Part 3, Specification for Spring Washers Section 3.6.

D. Additional requirements for insulated joints:

1. The electrical properties of the completed insulated joint shall meet the requirements of the Association of American Railroads (AAR) Signal Manual, Part 14.5. Refer to section 34 11 94 for insulated joint requirements.

2.5 PRE-CURVED RAILS

A. Pre-curve rail used for track curves having equal or less than 300-foot radius for continuously welded rail (CWR).

B. Pre-curved rail may be cropped at 36-foot lengths to allow for exact curve bending radii or spiral transition.

C. All rails shall be straight before pre-curving.

D. Precurved rail tolerances to be achieved are as follows:

1. Uniformly curved rail, such that the deviation of the measured interior mid ordinate offset from the theoretical offset, measured at any point, is within the following:

a. Ten foot chord: within 1/8 inch

b. Fifteen foot chord: within ¼ inch

c. Thirty foot chord: within 1 inch

2. Precurved rail bases shall bear fully on canted tie plates or rail fasteners when laid out on a flat surface. Camber rails vertically prior to making horizontal bends when necessary to meet this requirement.

3. Distortion in pre-curved rail base that prevents full bearing on canted plates will not be acceptable.

E. Curved rails shall be pre-curved in the shop by either gag press or roller bending methods.

F. Identify pre-curved rail with painted identity numbering per approved Shop Drawing code at the end of each rail, and paint identity numbers so that they are visible from both the top and the side of the rails.

G. Fabricate all pre-curved rail from the rail furnished by the CONTRACTOR.

H. Refer to Specification section 34 11 34 T “Standard and High Strength Rail” & 34 11 27 T “Ballasted Track Construction.”

PART 3 – EXECUTION

3.1 GENERAL

A. An installation plan shall be developed for each curve prior to fabrication of restraining rail.

B. The restraining rail lengths shall be precut in the shop to exact length for each curve.

C. End flares for the beginning and end pieces of restraining rail for each curve shall be milled in the shop before delivery to the site. Fabrication of end flares in the field is prohibited.

D. Rail shall be laid out for each location in accordance with the track geometry and fabricated with the adjacent running rail to provide fastening connections at correct locations.

3.2 SPECIAL TRACKWORK CONSTRUCTION

A. Subballast: Place sub-ballast as specified in SECTION 34 11 31 – SUBBALLAST, conforming to recommended practices in AREMA Chapter 1, Section 2.1.

1. Geotextile Fabric: Place geotextile fabric under all Special Trackwork. Fabric shall extend the entire interface zone between ballast and subballast. Fabric will extend 20 feet before point of switch and 10 feet after last long tie or as directed in the Contract Drawings.

B. Ballast: Place ballast as specified in SECTION 34 11 32 – BALLAST, conforming to recommended practices in AREMA Chapter 1, Part 2.

C. Switch Ties:

2. For wood ties in mainline turnouts, pre-bore 9/16-inch diameter holes in timber tie for ¾-inch lag screws with electrically isolated bushings.

3. For concrete ties in mainline turnouts, provide insulated fastening devices in accordance with manufacturer’s layout drawings.

4. Space and line switch ties in accordance with manufacturer’s layout drawings for the particular type of turnout or crossover being installed.

D. Plates and Pads for wood tie construction: Locate and secure all special and standard tie plates and tie pads as shown on the manufacturer’s drawings. Note that mainline and turnout plates are affixed to wooden ties with lag screws.

E. Turnout Elements: Assemble and install turnout elements in accordance with manufacturer's drawings and recommended practices as shown in AREMA Portfolio of Track Plans.

F. Surface and Align: Surface and line special trackwork as specified in SECTION 34 11 27 - BALLASTED TRACK CONSTRUCTION, except that switch ties shall be tamped uniformly throughout their entire length.

G. Switch Stands: Install switch stands in accordance with manufacturer's drawings and instructions at all manual switches as identified in Article 3.1.B of this Specification.

3.3 SHOP ASSEMBLY

A. Pre-Curved Rail Assemblies.

1. Provide shop drawings for pre-curved rail lengths by rail sequence number showing the radius for each rail length and its location in the track.

   a. Include the method of marking rails for identification and installation at least 30 days prior to commencement of pre-curving project rolled and approved.

   b. Mark Tangent to Spiral, Spiral to Curve, Curve to Spiral and Spiral to Tangent points where applicable.

2. Shop curved rails shall be per calculated lengths shown on the approved Shop Drawings plus or minus ⅛-inch.

3.4 IDENTIFICATION MARKING

A. Each piece of restraining rail shall be marked to indicate its proposed installed location.

B. Marks shall be in at least two locations on each piece, widely separated, located on the top to be visible after installation.

C. Bundle restraining rail quantities per each specific track curve and tag each bundle with the curve identification number.

3.5 HANDLING AND DELIVERY

A. Except as modified herein, handle, transport and store pre-curved rails and restraining rails in accordance with the current AREMA recommended practices. All rails shall be handled carefully and delivered in open top containers to avoid damage by kinking, bending, nicking, or other potential damage to the rail. Rails shall not be dropped or struck sharply. Handling and delivery shall be in accordance with accepted industry practice.

B. Small loose parts and miscellaneous hardware shall be delivered in secure boxes and kegs, each weighing not more than 80 pounds.

C. All bundles, boxes and kegs shall be clearly marked with the following information:

1. Identification of items contained

2. Supplier's name
3. Delivery date
4. Number of pieces
5. Gross weight

D. Bundle restraining rail quantities per each specific track curve and tag each bundle with the curve identification number.

E. Precurved rails shall be banded in groups and shipped together for each curve with rail head upward, if rails were stored at an off-site location. Each banded group shall be identified with stamped metal tag indicating:

1. The number of banded rail groups per curve.
2. The curve identification.
3. The total number of rails in the curve.

F. Precurved rails shall be wedged and blocked for shipment so as to prevent accidental bending of the rail.

END OF SECTION

SECTION 34 11 25

LRT – EMBEDDED TRACK CONSTRUCTION

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. The Work in this Section includes the construction of embedded track as shown on the Contract Drawings and as specified herein. The Work includes furnishing and placing a reinforced concrete track slab, embedded trackway PCC infill (center concrete infill and concrete edge infill), installing 115RE rail, rail boot and cuffs, coated C-shaped steel channel section with elastic clips & insulators, protective isolation caps, field rail welding and grinding, track drains, platform drains, lateral pipe connection from track or platform drains to storm drainage system, signal track connection boxes, elastomeric grout, joint sealant, and all required testing.

B. Measurement and Payment:

1. No separate measurement and payment will be made for the work described in this section.

1.2 RELATED SECTIONS

03 11 00 - Concrete Forming

03 20 00 - Concrete Reinforcing

03 30 00 - Cast-in-Place Concrete

31 23 16 - Excavation

32 11 23 - Aggregate Base Courses

32 13 13 - Concrete Paving

34 11 45 - Trackwork - Field rail welding

34 11 27 - Ballasted Track Construction

34 11 34 - Standard and High Strength Rail

1.3 REFERENCES

A. The following Codes, Regulations and Reference Standards apply to Work included in this Section:

Sponsor	Number	Subject
AASHTO	T277-07	Standard Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
AATCC	Test Method 16-2004	Colorfastness to Light (Weather-Ometer Test, American Association of Textile Chemists and Colorists)
ASTM	C579-01(2006)	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes
ASTM	C827-01a(2005)	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM	D1248-05	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM	D2564-04e1	Standard Specification for Solvent Cements for Poly Plastic Piping Systems
ASTM	D575-91(2007)	Standard Test Methods for Rubber Properties in Compression
ASTM	D5992-96(2006)e1	Standard Guide for Dynamic Testing of Vulcanized Rubber and Rubber-Like Materials Using Vibratory Methods
ASTM	D149-97a(2004)	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM	D3034-06	Standard Specification for Type PSM Poly Sewer Pipe and Fittings
ASTM	D1149-07	Standard Test Method for Rubber Deterioration-Cracking in an Ozone Controlled Environment
ASTM	D471-06	Standard Test Method for Rubber Property-Effect of Liquids
ASTM	D412-06a	Standard Test Methods for Vulcanized Rubber & Thermoplastic Elastomers-Tension
ASTM	D395-03	Standard Test Methods for Rubber Property-Compression Set
ASTM	D573-04	Standard Test Method for Rubber Deterioration in an Air Oven
ASTM	A36/A36M-05	Standard Specification for Carbon Structural Steel
ASTM	D789-07	Standard Test Methods for Determination of Solution Viscosities of Polyamide (PA)
ASTM	D257-07	Standard Test Methods for DC Resistance or Conductance of Insulating Materials
ASTM	D570-98(2005)	Standard Test Method for Water Absorption of Plastics

ASTM	D2240-05	Standard Test Method for Rubber Property-Durometer Hardness
ASTM	D732-02	Standard Test Method for Shear Strength of Plastics by Punch Tool
ASTM	D648-07	Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
ASTM	E162-06	Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
ASTM	D2137-05	Standard Test Methods for Rubber Property-Brittleness Point of Flexible Polymers and Coated Fabrics
AREMA		Manual for Railway Engineering
AREMA		Portfolio of Trackwork Plans
NFPA	No. 258(2001)	Recommended Practice for Determining Smoke Generation of Solid Materials

1.4 REFERENCE DRAWINGS

A. Manufacturer's Shop Drawings of UTA furnished rail are available to the CONTRACTOR from the ENGINEER. Shop drawings of CONTRACTOR furnished Materials shall be provided to the ENGINEER. In the event of a discrepancy between the manufacturer's Shop Drawings, the Contract Drawings, or Specifications, the information shown on the Shop Drawings approved by UTA shall take precedence.

1.5 SUBMITTALS

A. Submittals shall be made in accordance with the General Provisions, except as modified herein.

1. Designation of line and profile rail.

2. Submit a track Work Plan per Paragraph 3.5 of this specification for review and conditional acceptance by the ENGINEER at least thirty (30) Days prior to the installation of a demonstration section.

3. Detailed procedure for achieving uniform longitudinal rail stress for the zero stress temperature.

4. Thermite weld kits and weld grinding product data and procedures.

5. All certified test reports: including reports for electrical tests, rail boot & cuff, joint sealing materials and elastomeric grout.

6. Submit for the elastomeric grout the manufacturer's current published application instructions and the CONTRACTOR's detailed written procedures for the ENGINEER's review and acceptance 90 Days prior to commencing trackwork. Both documents shall address all of the following items:

    a. Identification of all Materials to be used by product number and description.

    b. Shipping, storing, and handling.

    c. Equipment identification, operation, and maintenance.

    d. Surface preparation to attain bond.

    e. Mixing, applying, and curing.

    f. Weather conditions.

    g. Public safety.

    h. Touch-up and repair.

    i. Quality control implementation.

    j. Conflicts between the manufacturer's instructions, applicator's procedure, and the Contract requirements shall be brought to the attention of the ENGINEER for resolution.

    k. Concrete curing time before application of elastomeric grout.

7. Submit for the railboot and cuff the following:

    a. Shop drawings and product data for railboot and cuff.

    b. Duration of production.

    c. Jointing procedure from boot to boot and product data for joint sealing material.

    d. Cuff installation and isolation at joints.

    e. Material composition of boot and cuff and identification.

    f. Isolation values of boot and cuff.

    g. Testing results for isolation, tensile, shear strength and shore hardness values.

    h. Shipment method. Minimum boot length to be shipped to the site shall be 230 ft long.

8. Submit for the coated C-shaped steel channel section with elastic clips & insulators, the following:

a. Drawings for the coated C-shaped steel channel section with elastic clips & insulators.

b. Properties of materials and specifications.

c. Clip toe load and pressure transfer to rubber boot.

d. Protective coating as identified in Paragraph 2.11 or approved equal.

9. Provide Shop Drawings and product data for a track drain and platform drain with formed concrete surfaces compatible with the proposed track components that will properly drain both concrete flangeways and pavement surface, as shown in the Contract Drawings for approval by the ENGINEER prior to fabrication and delivery. The CONTRACTOR shall provide installation and maintenance manuals for the track drain.

10. Provide Shop Drawings and product data for signal track connection boxes compatible with the proposed track components for approval by the ENGINEER prior to fabrication and delivery.

11. Qualifications: 90 Days prior to commencing trackwork, submit qualifications and experience record of superintendent and foremen proposed to be in charge of trackwork operations, as specified in Paragraph 1.5 and in accordance with the General Provisions. In addition, CONTRACTOR shall submit qualifications, testing program and procedures of the certified independent testing laboratory.

1.6 QUALITY ASSURANCE AND QUALITY CONTROL

A. The quality of all Materials and installation of Work shall be confirmed by the CONTRACTOR in accordance with the written quality control plan prepared by the CONTRACTOR and accepted by the ENGINEER in accordance with the General Provisions.

B. The quality control plan shall define the tests and measurements to be conducted by the CONTRACTOR, the instruments and equipment required, the frequency of tests, and the documentation of the results. All quality control work is the responsibility of the CONTRACTOR.

C. The quality control plan shall cover all phases of the Work from Material manufacture to trackwork completion, including at least the following specific items:

1. Material control and batch traceability.

2. Shipping, handling, and storage controls and measurements.

3. Equipment maintenance including calibration measurements and tests for contamination of compressed air lines.

4. Surface preparation measurements.

5. Environmental measurements such as temperature, dew point, relative humidity, rainfall, etc.

6. Mixing, applying and curing measurements such as component Materials viscosity and density, mixing ratios, and Material hardness at various cure times.

7. Provisions for test failure and retesting procedures.

8. Track alignment and geometry measurements and control.

9. Field rail welding and grinding control.

10. Select a certified independent testing laboratory to perform required testing, and submit its qualifications, testing program, and procedures to the ENGINEER for acceptance prior to using their services on the Contract. Provide certified reports to the ENGINEER indicating the material is acceptable prior to shipping the material to the job site.

D. The ENGINEER shall have access to witness all quality control tests and measurements and to review all documentation. CONTRACTOR shall give notice or schedule to ENGINEER when tests are to occur.

E. Incomplete or inadequate quality control documentation will be sufficient grounds for rejection of installed materials.

F. The Work of this Section shall be supervised by both a superintendent and foreman in charge of trackwork operations, each with 5 years documented experience in embedded track construction. 90 Days prior to commencing embedded track construction, submit the qualifications and experience record of the proposed trackwork superintendent and foreman.

G. Track Demonstration Section:

1. The CONTRACTOR shall install a demonstration section of embedded double track, including concrete infill between the tracks, to qualify the track Work Plan upon receipt of conditional approval of the Work Plan by the ENGINEER. Select the location of the track demonstration section to include a track drain, an electrical box, or preferably both.

2. The demonstration section shall be at least one construction cycle, a minimum of 80' in length, and shall be installed in strict accordance with the Work Plan herein. `Construction cycle' is defined as the average duration of construction activity required to completely install embedded track in any one of the areas of the Project.

3. Upon completion of the demonstration section, the CONTRACTOR shall verify conformance with the specified tolerances and track-to-earth electrical tests.

4. Unacceptable demonstration sections shall be repaired if possible or removed and replaced at the CONTRACTOR's own expense if the section cannot be repaired or brought up to the required standard to conform to all Contract requirements. If the demonstration section is being accepted but does not meet all Contract requirements, a reduced cost for the installed section shall be negotiated with UTA.

5. The demonstration track shall be constructed, fully tested, and accepted to the Specification requirements by the ENGINEER prior to initiation of any other track installation Work.

6. Upon acceptance of the demonstration section by the ENGINEER as part of the system, the CONTRACTOR's key personnel including, but not limited to, the CONTRACTOR's Project Manager, superintendent, track crew foreman, inspectors, surveyor, track Subcontractor foreman and quality control manager, shall meet with the ENGINEER to review the conduct of demonstration track construction. At the meeting, the CONTRACTOR and his personnel shall present any revised construction methods different from those approved, request any clarification of requirements and criteria, and address any procedural problems or suggest improvement for the ENGINEER/CONTRACTOR relationship for the duration of the trackwork construction. At the meeting, the ENGINEER will establish delivery dates for CONTRACTOR revised submittals and other action items arising from the meeting.

7. The ENGINEER will produce minutes of the demonstration review meeting that will document the results of the meeting.

1.7 SHIPPING, HANDLING AND STORAGE OF ELASTOMERIC MATERIALS

A. Pourable elastomeric Materials shall be delivered to the place of application in the manufacturer's unopened, original containers bearing a legible product designation, batch number and date of manufacture.

B. All Material shall be stored in accordance with the manufacturer's latest published instructions, and shall be protected as required by the manufacturer from damage, moisture, direct sunlight, and temperatures below or above those recommended by the manufacturer.

C. Containers of elastomeric Materials shall not be opened except for immediate use. Materials in damaged containers shall not be used if any of the contents were lost or exposed.

D. Materials with a shelf life shall be used within six months of their manufacture and in no case after the manufacturer's recommended shelf life.

E. Trackwork Materials shall be stored off-ground on pallets, timber dunnage, platforms, or other approved supports in a manner that will permit easy access for inspection and identification.

F. Operations likely to cause scratching, notching, rubbing, scoring, or striking of the rails during any handling operations shall not be used.

PART 2 – PRODUCTS

2.1 CONTRACTOR FURNISHED MATERIALS

A. The following new Materials shall be furnished by the CONTRACTOR:

1. Rail boot and cuffs.

2. C-channel with weld on shoulders and appurtenances.
3. Elastic Clips.
4. Composite Nylon Insulators.
5. Protective isolation caps for cover of elastic clips.
6. Track drains shall be as specified herein.
7. Platform drains shall be as specified herein.
8. Track slab concrete (1st and 2nd pour) shall be Class 4A (AE) in accordance with Section 03 30 00 “Cast in Place Concrete.”
9. Trackway PCC infill concrete for trackway edging and center of trackway concrete pavement shall be Class 4A (AE) in accordance with Section 03 30 00. The PCC infill slab shall be broom finished according to Section 03 35 00 “Concrete Finishing.”
10. Steel reinforcement shall be Grade 60, epoxy coated deformed bars in accordance with Section 03 20 00 “Concrete Reinforcing.
11. Bonded insulated joint kits shall be in accordance with Section 34 11 23.
12. Signal track connection boxes, and any surface covers subjected to traffic, shall be designed for HS20-44 AASHTO loading.
13. Weld kits as specified in Section 34 11 45 T “Trackwork – Field Rail Welding.”
14. Elastomeric Grout shall be as specified herein.
15. Any and all other Material not provided by the UTA necessary to provide a complete installation.
16. Standard rails and high strength 115 RE rails section in accordance with Section 34 11 34.
    a. Standard Rail (Brinnell hardness -310 HB) shall be use for mainline tangent tracks and for curve track with radii greater than 900 ft. Extent or limit of standard rail shall be as shown on the Drawings.
    b. High Strength Rails (Brinnell hardness -370 HB) shall be use for Station platform tracks, for curved track with radii equal to or less than 900ft. Extent or limit of high strength rail shall be as shown on the Drawings.

2.2 COATED C-CHANNEL AND RAIL BOOT FASTENER ASSEMBLY

A. Coated C-shaped steel channel section with weld-on shoulders, elastic clips, composite nylon insulators, and protective isolation caps shall be furnished complete for assembly of rail and railboot.

B. C-channel shall consist of ASTM A36 steel. Channels shall be C5x9, with weld-on shoulders installed, and shall have protective Polyflex Elastomeric Coating, or approved equal, per Paragraph 2.12. Coating shall be applied after weld-on shoulders are installed and shall be a minimum of 10 mil.

C. Rail clips shall be Pandrol e-2055, or approved equal, in accordance with these minimum design criteria:

1. The elastic clip shall consist of one piece only, with no threaded components, or approved equivalent.

2. There shall be two identical clips per plate installation designed to accommodate the anchor bolt and restraining rail assembly.

3. Rail holding force shall be generated by clamping force.

4. The minimum vertical hold down force per clip shall be 2,200 pounds.

5. Field assembly and disassembly shall be capable of being performed by one man using standard readily available track tools.

6. Elastic clips shall be proven design with a minimum of five years to the present time documented successful in-track experience in a North American rail transit system.

7. Elastic clips shall be manufactured from alloyed spring steel in accordance with BS 970 Part 2 (1988), Grade 251A58, or equivalent.

8. Formed elastic clips shall be heat treated to achieve a hardness of 44 to 48 Rockwell C.

9. Clips shall be free of burrs or flanges which might be considered harmful when handled, or which might affect the efficient installation of the clip.

D. Insulators shall be compatible with railboot and clip provided by CONTRACTOR, conforming to the following criteria:

1. Material: Nylon conforming to ASTM D 789, Type 1, Grade 2, ultra-violet stabilized. Do not use recycled material.

2. Volume Resistivity: 1012 ohm-cm, minimum. Measure in accordance with ASTM D 257.

3. Water Absorption at Saturation: 5.5 percent, maximum. Measure in accordance with ASTM D 570.

4. Hardness: Minimum 78, maximum 82, Shore D, when measured in accordance with ASTM D 2240.

5. Dry Shear Strength: 650 psi, minimum. Measure in accordance with ASTM D 732.

6. Deformation under Load: Five percent, maximum. Measure at 2000 psi and 50° C in accordance with ASTM D 621.

7. Deflection Temperature: 220° C, minimum. Measure in accordance with ASTM D 648.

8. Weatherometer Test: After 1000 hours with cycled water spray, the yield stress shall be a minimum of 8000 psi and the tensile strength shall be a minimum of 6000 psi. Measure in accordance with AATCC Test Method 16-2004.

9. Steel insert shall be cast steel in accordance with manufacturer's specifications for this product.

E. Elastomeric Grout:

1. Elastomeric grout shall be a two-component polyurethane material or approved equal consisting of a resin and a suitable hardener, mixed on site in accordance with manufacturer's instructions. Elastomeric grout shall be subject to the approval of the Resident Engineer.

2. Provide certification that the cured elastomeric grout possesses hard, elastic, vibration, and sound absorbing properties and provides the level of track-to-earth electrical resistance as specified herein.

3. Elastomeric grout shall have been used successfully in similar applications on at least three other railroad or transit properties for a minimum of the last five years.

4. Submit certification from the manufacturer that the installed product will withstand AASHTO HS25-44 loadings in an urban environment for a minimum of 5 years with no failure.

5. Test Requirements:

   a. Submit certification from a testing laboratory that the material to be installed in track will pass the tests listed below. The testing lab and its testing program and procedures shall be subject to the approval of the Resident Engineer.

   b. Test reports indicating acceptable material shall be received by the Resident Engineer before shipment of material to the job site.

6. Adhesion Test:

   a. Test Method: Per ASTM D 429, (Method C) performed on bare carbon steel cleaned to condition C St 2 as depicted in SSPC-Vis-1

   b. Acceptance Criterion: 300 psi minimum; cohesive or adhesive failure below 300 psi constitutes a test failure

7. Volume Resistivity Test:

a. Test Method: Per ASTM D 257, at 50 percent relative humidity and 75 degrees F shall be measured for a dry specimen and then the same specimen after 7 days immersion in a 3 percent NaCl solution. The specimen from the latter test shall only be wiped dry prior to testing and no more than one hour shall lapse from removal from immersion to performing the test.

b. Acceptance Criterion: 1012 ohm-cm minimum

8. Chemical Resistance Test:

a. Test Method: Per ASTM D 471 at 75 degrees F for 7 days. Report percent change in sample weight and volume.

b. Acceptance Criterion:

Solutions	Maximum % Weight	Change Volume
Water	1	1
10% NaCl	1	1
10% $CaCl_2$	1	1
5% H_2SO_4	2	2
5% NaOH	2	2
ASTM Oil No. 1	3	3
ASTM Oil No. 3	3	3
ASTM Fuel A	4	4

9. Hardness Test:

a. Test Method: In accordance with ASTM D 2240, report for cured specimens and specimens aged 24 hours at 75 degrees F.

b. Acceptance Criterion: Shore hardness A: 65 to 70.

10. Compression Modulus Test:

a. Test Method: In accordance with ASTM D 575, report deflection at 250 psi loading.

b. Acceptance Criterion: Deflection at 250 psi shall be a minimum of 1 percent and maximum of 12 percent of the sample thickness.

11. Compression Set:

a. Test Method: In accordance with ASTM D 395 (Method B) for 22 hours at 158 degrees F performed three times on same specimen. Report initial and incremental sets.

b. Acceptance Criterion: Incremental set from third test shall be a maximum of 1 percent.

12. Dynamic Deflection Test:

a. Test Method: In accordance with ASTM D 5992 at two cycles per minute for 16 hours or to failure. Compression shall be 25 percent. Report failure, type of failure and any compression set.

b. Acceptance Criterion: No failure.

13. Dielectric Strength Test:

a. Test Method: In accordance with ASTM D 149

b. Acceptance Criterion: 400 volts/mil minimum

14. An acceptable elastomeric grout product shall be Icosit KC340/65 polyurethane grout manufactured by Sika Corporation:

Mill Creek, WA
(425) 486-5916

a. Or an approved equal with five-year history of proven acceptable experience.

2.3 FILL PLATES

A. Fill plates are required for some C channels as shown on drawings. Thickness shall be as shown on drawings with A-36 steel with two slotted holes for lateral adjustment. Plates shall have welded shoulders to accommodate the specific clips used.

2.4 RUBBER BOOT AND CUFF EXTRUSIONS

A. Elastomeric rubber boot and cuff extrusions shall be pre-formed continuous extruded elastomeric material with a minimum length of 230'. Elastomeric rubber extrusion and cuff material shall be manufactured Santoprene 591-73 W 175 Thermoplastic Rubber or approved equal as specified herein. The boot shall be glued or affixed to the rail in a manner that the boot and rail operate as a single element. Rubber rail boot shall be installed per manufacturer’s instructions. Cuff extrusions shall be fusion welded or bonded to the rubber extrusion boot at the joints with an approved fusion welding process or an approved bonding process by the manufacturer for this rubber boot process. The bonding material shall be a proven material and shall have been successfully applied on other similar track projects for at least five years. No electrical leakage shall occur at these joints.

B. Test Requirements:

1. The CONTRACTOR shall submit certification from a testing laboratory that the Material to be installed in track will pass the tests listed below. The testing lab and their testing program and procedures shall be subject to the approval of the ENGINEER.

2. Test reports indicating acceptable Material shall be received by the ENGINEER prior to shipment of Material to the job site.

C. Volume Resistivity:

1. Test Method: Per ASTM D 257, at 50% relative humidity and 75° F shall be measured for a dry specimen and then for the same specimen after 7 Days immersion in a 3% NaCl solution. The specimen from the latter test should only be wiped dry prior to testing and no more than 1 hour shall lapse from removal from immersion to performing the test.

2. Acceptance Criterion: 1012 ohm-cm minimum

D. Chemical Resistance

1. Test Method: Per ASTM D 471 at 75° F for 7 Days. Report percent change in sample weight and volume.

2. Acceptance Criterion:

Solutions	Maximum % Weight	Change Volume
Water	1	1
10% NaCl	1	1
10% $CaCl_2$	1	1
5% H_2SO_4	2	2
5% NaOH	2	2
ASTM Fuel A	30	-

3. Test Method: Per ASTM D 471 at 212° F for 7 Days. Report percent change in sample weight and volume.

4. Acceptance Criterion:

Solutions	Maximum % Weight	Change Volume
ASTM Oil No. 1	32	-
ASTM Oil No. 3	65	-

E. Tensile Properties:

1. Test Method: Measure tensile properties in accordance with ASTM D412.

2. Acceptance Criterion:

   a. Tensile Strength: 850 psi min.

   b. Ultimate Elongation: 240% min.

F. Compression Set:

1. Test Method: Per ASTM D 395 (Method B) for 22 hours at 158° F performed three times on same specimen. Report initial and incremental sets.

2. Acceptance Criterion: Incremental set from third test shall be a maximum of 3%.

   a. Retention of ultimate elongation: Minimum 75 percent.

   b. Change in hardness: Maximum 10 points Durometer Shore A.

G. Resistance to aging in air:

1. Test Method: ASTM D 573 - 72 hours at 100° C.

2. Acceptance Criterion: Retention of tensile strength: Minimum 75 percent.

H. Resistance to ozone cracking:

1. Test Method: Test specimens prepared in accordance with ASTM D1149 and measure specimen's resistance to ozone cracking in accordance with ASTM D 1149 at a temperature of 40° C and an ozone concentration of 50 pphm.

2. Acceptance Criterion: The rubber extrusion shall not exhibit any cracking when examined in accordance with ASTM D 1149 at the end of 100 hour exposure.

I. Resistance to oil:

1. Test Method: ASTM D 471 - 70 hours at 23° C in ASTM No. 1 oil

2. Acceptance Criterion: Volume change shall not exceed -10 percent or +20 percent.

J. Flame spread and smoke generation:

1. Test Method: ASTM E 162 and NFPA No. 258 - Determine flame propagation index (Is) and smoke generation specific optical index (Ds) for flaming and nonflaming modes.

2. Acceptance Criterion: The elastomer shall not exhibit any flaming drippings when tested. No acceptance criteria are specified for the flame propagation index (Is) and smoke generation specific index (Ds). These indices shall be reported to the ENGINEER for information only.

K. Compression Modulus:

1. Test Method: Per ASTM D 575 (Method B), report deflection at 250 psi loading.

2. Acceptance Criterion: Deflection at 250 psi shall be a minimum of 1% and maximum of 20% of the sample thickness.

L. Dynamic Deflection:

1. Test Method: Per ASTM D 5992 at two cycles per minute for 16 hours or to failure. Compression shall be 25%. Report failure, type of failure and any compression set.

2. Acceptance Criterion: No failure

M. Dielectric Strength:

1. Test Method: Per ASTM D 149

2. Acceptance Criterion: 400 volts/mil, minimum

N. Hardness:

1. Test Method: Per ASTM D 2240, report for cured specimens and specimens aged 24 hours at 75° F.

2. Acceptance Criterion: Shore hardness A of 70 ± 10 at the rail flange edge and at the grade edge.

O. Low Temperature Resistance:

1. Test Method: Measure low temperature resistance in accordance with ASTM D 2137, Method A, after 3 minutes at 40 degrees F.

2. Acceptance Criterion: Specimen is non-brittle.

P. Water Absorption:

1. Test Method: Measure water absorption in accordance with ASTM D570 after 168 hours at 77 degrees F.

2. Acceptance Criterion: 1 percent, maximum, by weight.

Q. Oil Swell:

1. Test Method: Measure oil swell in accordance with ASTM D471 after 70 hours at 212 degrees F.

2. Acceptance Criterion: 60 percent, maximum, by weight

R. Submit certification and test reports from the manufacturer that the installed product will withstand:

1. AASHTO HS20-44 loadings in an urban environment for a minimum of 5 years with no failure. Failure is defined as the product not capable of carrying a vehicle or pedestrian in a smooth and safe manner from pavement to rail, requiring replacement or repair of the product.

2. The pressure and abrasion of heavy bus and truck traffic with studded tires and/or chains, and to provide a non-skid surface for a minimum of 5 years with no failure.

3. That the strength of the adhesive used to join adjacent sections is at least 70% of the cohesive strength of the elastomeric rubber extrusion insert.

2.5 TRACK DRAIN, CURB DRAIN AND PLATFORM DRAIN

A. The track drains shall be fabricated steel grates that fit between the rails of one track to drain the trackway surface and the concrete at the rail flangeways. Rail must be isolated from steel grates. Trough shall be formed in concrete. Metal grating shall be designed to carry HS20-44 AASHTO loading. Steel angle support and bolting of grating to angles shall be strong enough and designed to transfer HS20-44 AASHTO loading into the concrete slab. Angles shall have diagonal Nelson studs welded on to secure them tightly into the concrete.

B. The track drain shall be as shown in the Contract Drawings.

C. The track drain assembly shall be manufactured to fit 115RE rail laid at the specified track gauge of 4' -8½” ± ⅛”. The drain shall be constructed so that the top of the grate will not extend higher than 1/4" below the top of railhead elevation, and shall be sloped to match track slab.

D. Curb and platform drains shall be as prefabricated by D & L Foundry & Supply, Type I – 4162 Bridge Deck Drain Inlet Box & Grate, or approved equal.

E. The drains to storm drain or inlet shall be SDR 35 PVC pipe.

2.6 SIGNAL TRACK CONNECTION BOXES

A. The signal track connection boxes shall be as shown in the Contract Drawings.

B. The box assemblies shall be manufactured to fit 115RE rail laid at the specified track gauge. The top of the box shall be −¼” below the top of the rail head, and shall be sloped to match track slab.

C. The box assemblies shall be bolted to the 115RE rails with standard ⅞" galvanized bolts complete with hexagonal head nuts and 2" outside diameter spring washers. All bolts, nuts & spring washers shall conform to ASTM A325 standards. The box floor shall have holes as shown on the Contract Drawings.

D. The signal track connection box assemblies shall be manufactured from ASTM A 36 steel and be capable of supporting an AASHTO HS20-44 loading. The signal and traction power track connection box may be fabricated with a polymer product and be capable of supporting inclusive housing and grating an AASHTO HS20-44 loading.

E. The signal track connection boxes shall be isolated from the trackslab and PCC infill slab with ½" PVC liner boot in accordance with the volume retention of the isolation liner as specified in Article 2.12 of this specification section.

2.7 CONCRETE TRACKSLAB

A. Track slab concrete (1st pour and 2nd pour) shall be Class 4A (AE) per Section 03 30 00 “Cast in Place Concrete.”

B. Trackway PCC infill concrete for trackway edging and trackway center concrete pavement shall be Class 4A (AE) in per Section 03 30 04. The PCC in fill slab shall be finished according to Section 03 35 00 “Concrete Finishing.”

C. Concrete reinforcement shall be epoxy coated deformed bars in accordance with Section 03 20 00 “Concrete Reinforcing.”

D. Expansion Joint and Contraction Joint (Tooled Joint or Control Joint) shall be as follows:

1. Contraction joint spacing shall be less than or equal to 10 feet, and shall be positioned over the C-channel tie. Contraction joints shall be a 3/4” deep sawcut and filled with joint sealant according to Section 07 92 00 “Joint Sealants.”

2. Expansion joint spacing shall be not further apart than 100 ft and shall not be over a C - channel support. Expansion joints shall be at the same location through the base slab and infill slab pours. Expansion joints shall be executed as shown on contract drawings and surface joint for 2” depth shall be filled with joint sealant according to Section 03 92 00. The remainder shall be filled with a preformed joint filler 3/4” in thickness.

2.8 PROTECTIVE ISOLATION CAP

A. Protective isolation cap thickness is to be a function of the strength of the material used for fabrication. The minimum thickness shall be 1/8” and shall carry the wet concrete weight above the cap during installation or 50 lbs per square foot.

B. Test Requirements:

1. The CONTRACTOR shall submit certification from a testing laboratory that the material to be installed in track has passed the tests listed below. The testing lab and their testing program and procedures shall be subject to the approval of the ENGINEER.

2. Test reports indicating acceptable material shall be received by the ENGINEER prior to shipment of material to the job site.

C. Volume Resistivity:

1. Test Method: Per ASTM D 257, at 50% relative humidity and 75° F shall be measured for a dry specimen and then for the same specimen after 7 Days immersion in a 3% NaCl solution. The specimen from the latter test should only be wiped dry prior to testing and no more than 1 hour shall lapse from removal from immersion to performing the test.

2. Acceptance Criterion: 1012 ohm-cm minimum

D. Dielectric Strength:

1. Test Method: Per ASTM D 149.

2. Acceptance Criterion: 50 kV minimum

E. Chemical Resistance:

1. Test Method: Per ASTM D471.

2. Acceptance Criterion: Resistant to most acids and alkali, no visual or measurable loss of original proper ties.

F. Absorption of Moisture:

1. Test Method: Per ASTM D570.

2. Acceptance Criterion: Less than 0.45% water absorption by weight.

G. Tensile Strength:
ASTM D 638 Elongation at break 10,000 psi

H. Flexural Modulus- Tangent
ASTM D 790 3.5%

I. IZOD Impact –Unnotched
ASTM D 4812 780,000 psi

J. Heat Deflection Temperature
ASTM D 648 @ 66 psi 9.0 ft-lbs/in. 315 deg. F

2.9 PVC DRAIN

A. SDR 35 PVC drains shall conform to the following specifications:

1. SDR 35 PVC drain	ASTM D 3034
2. PVC Fittings	ASTM D 3034
3. Solvent Cement	ASTM D 2564

2.10 POLYFLEX ELASTOMERIC PROTECTIVE COATING

A. Polyflex Elastomeric Coating is manufactured by Polyval and shall be used for covering C- channel or approved equal. Manufacturer can be contacted at (450) 430-6780 and has the following website: http://www.polyvalcoatings.com/

B. Physical Properties:

Effective Gel Time	2.5 seconds
Tensile Strength, psi	2255
% Elongation	225
Tear Strength, psi	430
Shore D Hardness	52
100% Modulus, psi	1565
Taser Abrasion, mg wt loss	160
Volume Resistivity (ASTM D257) OHM CM	3.27 x $10E^{13}$

PART 3 – EXECUTION

3.1 GENERAL

A. Track construction shall conform to AREMA Specifications for Track Construction except as modified herein. All track shall be insulated for signal purposes and equipped with track drains, signal boxes, as shown in the Contract Drawings.

3.2 TRACK ALIGNMENT AND GEOMETRY

A. General: The track shall be constructed to the alignment and profile indicated, within the tolerances specified.

B. Profile Rail: The CONTRACTOR shall designate right or left rail, while facing in the direction of increasing stationing, to control the grade of all tangent tracks on a Contract-wide basis. The low or inner rail on all curves shall be used to control grade.

C. Line Rail: The CONTRACTOR shall designate right or left rail, while facing in the direction of increasing stationing, to control the alignment of all tangent tracks on a Contract-wide basis. On curves, the outside rail shall be designated the line rail.

D. After completion of the embedded track installation, but before installation of the 2nd pour track slab concrete sections, the CONTRACTOR shall perform a survey of the finished rails to determine the actual horizontal and vertical alignments, track gauge and cross level. The alignment and profile as installed for this phase shall be accepted by UTA before proceeding further with any work. Any deviations in the final alignment exceeding the embedded track construction tolerances shall be corrected by the CONTRACTOR before continuation of the work.

E. Maintain monuments for the duration of the Work. Maintain an accurate surveyor's field book, accessible by the ENGINEER at any time, indicating all checks of the trackwork alignment. Record deviations from the design alignment that are accepted by the ENGINEER.

3.3 INSTALLATION TOLERANCES

A. Deviations from indicated gauge, cross level, horizontal line, and profile grade shall conform to the following requirements:

1. Embedded track gauge shall be 4'-8 ½”, unless stated otherwise in the Drawings.

2. Embedded track cross level shall be ± ⅛" from level on tangent and from designated superelevation on curve.

3. For embedded tracks, maximum deviation from horizontal alignment is no greater than as follows:

a. ± ⅛" in the middle ordinate of a 62' chord.

b. +/− ½” total except at passenger stations where total deviation shall be +1/2” and –0”.

4. Deviation from profile grade shall not exceed ± ⅛" in a 62' chord or a total of ± ¼".

3.4 TOOLS AND EQUIPMENT

A. On-track equipment shall conform to AREMA Specifications for On-track Roadway Machines and Work Equipment.

B. Construction equipment operated on the track slab or the tracks shall be in good repair and with all safety and protective appliances in place and functioning.

C. CONTRACTOR's equipment shall not exceed clearance requirements and the design loads shown as identified in the UTA Light Rail Design Criteria Manual, Revision 6, which will be furnished by the UTA upon request by CONTRACTOR. Further information concerning vehicle characteristics will be provided by the UTA upon request by CONTRACTOR. CONTRACTOR shall verify that proposed equipment meets these requirements.

D. Construction equipment with rail wheels shall not be allowed on the tracks if any of the wheels exhibit a flat spot of length greater than 8% of the wheel diameter.

E. Tools used in track construction shall conform to AREMA Specifications and Plans for Track Tools, or as approved by the ENGINEER. All tools shall be calibrated as appropriate for the use.

F. Do not use on-track construction equipment that exceeds the structural design loads of the track.

G. Cosmetic stains caused by leaking equipment shall be completely cleaned to the satisfaction of UTA and structural damage caused by leaking liquids shall be cause for the constructed item to be demolished and replaced.

H. Furnish a rail-mounted track inspection apparatus capable of measuring all parameters specified with sufficient accuracy to establish that track construction is within the tolerances specified. Submit the make, model, and catalog data for the Track Inspection Car.

3.5 TRACK WORK PLAN

A. As part of the Track Work Plan, the CONTRACTOR shall pay particular attention to the maintenance of a clean track section through all stages of the work. The ENGINEER shall be contacted a minimum of 24 hours in advance of all steps of the installation. The CONTRACTOR must assure the ENGINEER that the rail has been sealed in a finished installation that is entirely clean and free of debris. Particular care shall be taken to keep the rail boot absolutely clean during installation by inspecting the inside of the rail boot to ensure that no rocks, dirt or other construction debris has fallen into the boot just prior to installing it to the rail.

B. The Work Plan shall describe the Material handling, construction methods, sequence, environmental constraints, maintenance of access and traffic, and coordination with other CONTRACTORs in the vicinity for all Work, including the following:

1. Preparation of subgrade and installation of aggregate base Material as shown on the Plans.

2. Construction method of the concrete track slab whether single pour or double pour method. Installation of track slab’s stub ups, block outs and construction joints.

3. Assembly and installation of the C-channel rail fastener assembly, boot, cuffs, rail, track and platform drains, and signal track connection boxes.

4. Installing rail clips and attaching rail to the specified horizontal and vertical alignment within tolerances.

5. Installation of bonded insulated joints and performing Thermite field rail welds in the field to reconnect CWR strings.

6. Installation of track slab’s reinforcement whether single pour or double pour method.

7. Rail Layout Plan showing location and sequence of the field welds and bonded insulated joints.

8. Methods to meet the rail temperature requirements.

9. Surface preparation of concrete, concrete groove and installation of rail.

10. Intermittent rail testing shall be in accordance with specified criteria for rail to track slab before installation of concrete infill as specified in Paragraph 3.13 and 3.14.

C. Provide an installation schedule defining the sequence of operations by which the Work will be performed and the anticipated duration of each operation. Describe each installation operation in detail, indicating the Materials, manpower and mechanical equipment needed.

D. Final Acceptance of the Work Plan by the ENGINEER is contingent upon installation of an acceptable demonstration section. Production track installation shall not begin until the ENGINEER has accepted the Work Plan.

3.6 PREPARATION OF SUBGRADE

A. The subgrade shall be formed and prepared as shown on the Contract Drawings and in accordance with Section 31 23 16 “Excavation.”

3.7 AGGREGATE BASE COURSE

A. Aggregate base course shall be furnished and installed in accordance with Section 32 11 23 “Aggregate Base Courses.”

3.8 CONCRETE TRACK SLAB

A. Install the reinforced concrete track slab as follows:

1. Tolerance on the elevation of the top of the concrete track slab immediately adjacent to field side of the rail head shall be plus 0”, minus ⅛". The tolerance shall be based that the track slab is ¼” below top of rail head as shown on drawings. Tolerance on the elevation of the top the remaining portion of the concrete track slab shall adhere to Article 3.7 of Section 32 13 13 “Concrete Paving.”

2. Slab penetrations, block outs and surface modifications for drainage structures, box electrical conduits, shall be as shown on the Contract Drawings.

3. Inspection shall be by the CONTRACTOR's personnel who will have responsible charge of the Work. All defects in the base Material shall be corrected prior to placement of the concrete track slab.

4. The concrete track slab shall be placed as shown on the Contract Drawings, in accordance with Sections 03 11 00 “Concrete Forming”, 03 20 00 “Concrete Reinforcing”, 03 30 00 “Cast in Place Concrete” and as specified herein.

5. The track slab shall be installed in two pours with a cold horizontal pour joint. CONTRACTOR may consider pouring track slab in a single pour. For approval of the single pour method, please refer to Paragraph 3.13, “Final Alignment and Track Inspections”, in this section.

6. Provide concrete slab expansion joints, controlled tool joints, and devil strip joints as shown on the plans to produce a square appearance being perpendicular to the rails.

7. During installation of the concrete track slab, particularly during installation of the PCC infill slab, the rail head shall be protected by mastic tape or other suitable material to prevent the rail head being spluttered with concrete.

3.9 RAIL INSTALLATION

A. Rail Distribution: The rails shall be transported and unloaded in accordance with the recommendations of Chapter 5, Track, of the AREMA Manual. Layout of the rails shall conform to the Work Plan.

B. Field rail welding shall be done in accordance with Section 34 11 45 “Trackwork – Field Rail Welding.”

C. Cutting and Drilling:

1. Holes or cuts will not be permitted except where shown on the Plans and as specified herein.

2. Rails shall be cut square and clean by using rail saws or abrasive cutting discs only. Flame cutting of the rail using plasma cutters and all ordinary types of cutting torches will not be allowed. Burrs and excess metal on the rail ends shall be removed after cutting by grinding.

3. Rails shall not be cut for the installation of a bolted or bonded joint within 3' of a shop weld.

4. Holes shall be drilled in accordance with the requirements of AREMA Manual, Chapter 4, Section 2.1, "Specifications for Steel Rails”. Holes shall not be punched, shot, slotted, or burned with a torch.

D. Destressing Rail:

1. Rail zero stress (neutral) temperature at final closure and fastening shall be 100° F ± 5° F.

2. The rail length at final closure shall be the thermally adjusted length based on the unconstrained rail length plus field weld lengths as follows:

$$Lzst = \Sigma[Lsr \{1+(\alpha) (Tzst-Tsr)\}] + \Sigma Lgap$$

where:

Lzst = In-track Rail Length at the Zero Stress Temperature

Lsr = Unconstrained length of individual rail strings measured at the weld plant after completion of each string

Tsr = Rail temperature of each rail string at the time of the Lwp measurement

Tzst = Zero stress temperature

α = Coefficient of thermal expansion = 6.5 x 10-6 inch per degree Fahrenheit field weld

Lgap = Length of each field weld rail gap

3. The rail shall have a uniform longitudinal stress along the entire fastened length (except at free ends).

4. The CONTRACTOR shall submit a detailed procedure for achieving uniform longitudinal rail stress for the zero stress temperature specified in Paragraph 3.9.D.1.

5. Final closure shall be by a field weld with the rail fully fastened (except immediately adjacent to the field weld as necessary to perform the weld) near or at final elevation and alignment. If post closure rail realignment is required, the CONTRACTOR shall provide sufficient longitudinal restraint either side of the location of realignment to assure the rail stress state is not changed by the realignment Work.

6. CONTRACTOR shall notify ENGINEER 24 hrs in advance of rail destressing activities.

E. Rail Grinding:

1. Upon completion of the embedded track installation to within the specified tolerances, but prior to its final acceptance, use a rail mounted grinder to touch up all running rail surfaces by contour grinding the curved contour of the rail head to provide similar head configurations and radii.

   a. Remove all rust, mill scale, and surface irregularities with successive passes of the rail mounted grinder. Lightly grind the top and gauge side corner of the running rail head as to limit nominal metal removal to 1/32 inch. Grinding shall not alter the as-rolled rail head contour and radii. Residual surface grinding & machining marks shall not be deeper than 0.010 inch.

   b. Rail grinder shall be a machine with not fewer than four grinding stones. The grinding wheels shall not be less than 10 inches in diameter and shall have controlled downward pressure to permit grinding more metal per pass at high spots and bridging at low spots less than 10 inches in length. Submit the type of rail grinding equipment and method of operation to the Resident Engineer for acceptance prior to initiation of rail grinding.

c. CONTRACTOR shall detail how many passes he intends to do, what type of stones for initial and fine grinding he will use and with what speed he is going to proceed. CONTRACTOR shall submit from at least one former project he successfully completed with references work done and specifications for the submitted project.

d. Grinding of the rail head to remove mill scale and surface irregularities may be undertaken at the rolling mill, subject to acceptance of the procedure by the ENGINEER. Post-installation field grinding to remove subsequent rail head surface oxidation may still be required.

2. Remove all filings due to grinding throughout the entire trackway using a vacuum process.

3.10 TRACK AND PLATFORM DRAIN INSTALLATION

A. Install drains as indicated in the Contract Drawings.

B. Construct the track drain so that the top of frame and gratings does not extend more than ¼” below the top of rail elevation with a tolerance of installation +0”, -1/8” variation. Track drain’s frame and gratings on recess (trough) track section shall be as constructed as shown on the Drawings, sloped to match track slab.

C. Make the drain pipe connections to the track drains as shown on the plans. Install drains so that the drain outlets properly connect to drain pipes as indicated in the Contract Drawings.

D. Pour elastomeric grout at locations as shown on Contract drawings for elastic separation and electrical isolation.

3.11 SIGNAL TRACK CONNECTION

A. Install boxes as indicated on the Contract drawings.

B. Connect drains and electrical conduits as indicated on the Contract drawings.

C. Pour elastomeric grout at locations shown on Contract drawings for elastic separation and electrical isolation.

3.12 BONDED INSULATED JOINTS

A. Bonded insulated joints shall not be located closer than 3" from the end of the insulated joint bar to the face of C-channel.

B. Bonded insulated joints shall be staggered at least 3' from the insulated joint on the opposite rail, unless otherwise noted on the Contract Drawings or approved by the ENGINEER.

C. Two signal track connection boxes shall be installed at each insulated rail joint and at other locations as shown on the Contract Drawings.

3.13 FINAL ALIGNMENT AND TRACK INSPECTIONS

A. The final horizontal and vertical alignment, gauge, cross level, and superelevation shall be within the tolerances specified. In order to determine the acceptability of finished track immediately after construction, the CONTRACTOR shall furnish and operate a rail-mounted track inspection device or provide a survey capable of measuring the parameters specified above with sufficient accuracy to establish that the track construction is within the tolerances specified herein.

B. Track geometry deviations, as disclosed by the inspection specified above, shall be corrected and necessary reinspection before the infill concrete section is poured and shall be performed to ascertain that corrections can be made prior to final acceptance of the track geometry and profile.

C. The CONTRACTOR is advised to use the two-pour method for the trackway slab so track gauge and profile can easily be corrected at this stage. Track geometry inspection shall occur after track slab and rail with boot has been installed and finally fastened but before pouring the 2nd pour track slab concrete. Single pour system will only be allowed if the CONTRACTOR can demonstrate to the satisfaction of the ENGINEER that the procedure will result in track which meets the specified tolerances. The UTA retains the right to mandate that severely out-of-tolerance track be removed and reconstructed at no additional cost to UTA.

3.14 ELECTRICAL TESTS

A. As the Work of this Section and Section 34 11 27 “Ballasted Track Construction” proceeds, perform track-to-earth electrical resistance tests at a minimum of one test per track every 200', on completed track.

B. In addition, an intermediate track-to-base slab test shall be performed every time a track section has been completed, and before the PCC infill slab is placed.

C. Undertake corrective measures at all locations that do not meet the track-to-earth electrical resistance requirements, as specified. The corrective measures shall extend to the next tested location that meets the specified requirements. The corrective measures shall require removal and replacement of any and all insulating Materials in the track, at CONTRACTOR's expense, until the requirements of Section 26 08 00 are met.

D. Particular attention to the testing shall be placed at locations of the rail boot locations being joined by cuffs to obtain the required electrical isolation.

E. Testing shall be preferably done before the field welds are installed to connect to the adjacent section or commencement of the next track section.

F. Retest the track-to-earth electrical resistance at the corrected locations, as specified.

3.15 TRACTION ELECTRIFICATION AND SIGNAL BONDING

A. Traction power bonds and signal bonds shall be installed as shown on the Contract Drawings and in accordance with the requirements of Section 26 05 26 “Grounding and Bonding for Electrical Systems”.

3.16 SHIPPING, HANDLING AND STORAGE OF ELASTOMERIC GROUT

A. Pourable elastomeric grout shall be delivered to the place of application in the manufacturer's unopened, original containers bearing a legible product designation, batch number, and date of manufacture.

B. Material shall be stored in accordance with the manufacturer's latest published instructions and shall be protected, as required by the manufacturer, from damage, moisture, direct sunlight, and temperatures below or above those recommended by the manufacturer.

C. Containers of elastomeric grout shall not be opened except for immediate use. Materials in damaged containers shall not be used if any of the contents were lost or exposed.

D. Materials with a shelf life shall be used within six months of their manufacture and in no case after the manufacturer's recommended shelf life.

3.17 INSPECTION OF MATERIALS

A. All material furnished in this Contract shall be presented for inspection at the place of manufacture. For the inspection of rail, the terms set forth in AREMA Specifications for Rail, Volume I, Chapter 4 and the approved shop drawings shall take precedence.

B. The CONTRACTOR shall afford the ENGINEER access and, without charge, all necessary facilities to examine the work, at any time during this progress, as well as the finished product, to satisfy the ENGINEER that the materials comply with these specifications. Regular examination of the product will take place during normal working hours.

C. Material for inspection shall be presented in a safe area away from excessive noise and manufacturing activities. Excessive noise shall be considered any sound or sounds in excess of 70 Db.

D. The CONTRACTOR shall send the ENGINEER written notice for inspection at least 30 working days in advance of availability for inspection.

E. Inspection of CONTRACTOR supplied 115RE rails for acceptance by UTA shall be in accordance with the requirements of Section 34 11 34 "Standard and High Strength Rail."

END OF SECTION

SECTION 34 11 27

LRT – BALLASTED TRACK CONSTRUCTION

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. This specification specifies the construction of ballasted trackwork on concrete ties.

1.2 RELATED SECTIONS

31 23 16 – Excavation

31 05 19 – Geotextiles

31 05 21 – Geogrids and Geocomposites

32 11 32 – Ballast

34 11 31 – Subballast

34 11 33 – Special Trackwork

34 11 35 – Concrete Ties

34 11 25 – Embedded Track Construction

1.3 REFERENCES

Sponsor	Number	Subject
ASTM	C29/C29M-07	Standard Test for Bulk Density and Voids in Aggregate
ASTM	C88-05	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfates
ASTM	C117-04	Standard Test Method for Materials Finer than 75-um Sieve in Mineral Aggregates by Washing
ASTM	C127-07	Standard Test Method for Density, Relative Density and Absorption of Coarse Aggregate
ASTM	C136-06	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM	C142-97(2004)	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM	C535-03e1	Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los

		Angeles Machine
ASTM	C702-98(2003)	Standard Practice for Reducing Samples of Aggregate to Testing Size
ASTM	D75-03	Standard Practice for Sampling Aggregates
ASTM	D4791-05e1	Standard Test Method for Flat Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM	D1557-XX	Standard Compaction Test
AREMA	Vol.1, Chapter 1, Part 2	Manufacture of Rail
AASHTO	T191	Standard Method of Test for Density of Soil in-Place by the Sand Cone Method
ASTM	D6938-07b	Standard Test Method for In-Place Density and Water Content of Soil and oil-Aggregate by Nuclear Methods

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the General Provisions, except as modified herein:

1. Designation of line and profile rail.

2. A report with detailed description of installation procedures required for the work specified in this Section.

3. Working Drawings, including the following:

   a. Complete details for distributing CWR, including a rail schedule.

   b. Complete details of the proposed methods, including equipment, of laying and fastening CWR and bolted rail.

   c. Location of proposed field cuts and field welds in CWR on the rail schedule.

4. Ballast tamping procedure.

5. Superelevation tag detailed drawing showing dimensions, material and stamped (or embossed) information, and the method for fixing the tag to the track support structure.

6. Track Inspection Procedure:

7. CONTRACTOR shall submit equipment and plan for the track inspection.

8. The equipment proposed for vibrating the rail.

9. The method and equipment proposed for achieving zero thermal stress in the rail.

10. CONTRACTOR shall submit the process for the rail grinding operations.

PART 2 – PRODUCTS

2.1 BALLAST MATERIAL

A. See Section 34 11 32, “Ballast.”

2.2 SUBBALLAST MATERIAL

A. See Section 34 11 31, “Subballast.”

2.3 TRACK MATERIAL

A. Contractor Furnished Materials:

1. The CONTRACTOR shall furnish all other material required and services to construct trackwork, including but not limited to those materials listed below. All materials shall be new material, unless otherwise indicated. Sorting, cropping, removal and plant welding is covered in Section 34 11 31, “Subballast”

   a. Standard rail and high strength rail in 80 ft lengths.

   b. Standard, restraining rail and 10’ transition concrete ties.

   c. Precurved, head-Hardended Rail according to section 34 11 33 T “Special Trackwork.”

   d. Superelevation Tags: Tags used to mark the superelevation on curved track shall be made of a corrosive resistant metal such as anodized aluminum or brass. Tags shall be stamped in ¼ inch increments from zero superelevation to maximum superelevation. Stamp identification lettering shall be a minimum of ½ inch in height. Tags shall be a minimum of 0.050 inch thick, 1 ¼ inches wide and two inches long.

   e. Subgrade Geotextile Fabric: Fabric for use in track subgrade stabilization shall be Non-woven Polypropylene, Polyester or Polyethylene and shall conform to the material & performance requirements established in Section 31 05 19 “Geotextiles” and 31 05 21 “Geogrids and Geocomposites.”

   f. Any and all other material required to provide a complete track installation.

PART 3 – EXECUTION

3.1 TOLERANCES

A. The ballasted track template shall be formed to maintain track gauge, cross level, horizontal and vertical alignment tolerances as defined herein.

Track Type	Gauge	Cross Level	Total Deviation Horizontal	Middle Ordinate (62-ft chord)	Total Deviation Vertical	Middle Ordinate (62-ft chord)

Mainline Ballasted Track	+/- 1/8”	+/- 1/8”	+/- 1/8”	+/- 1/8”	+/- 1/4”	+/- 1/8”

3.2 SUBBALLAST PLACEMENT

A. Subgrade Preparation:

1. The existing subgrade shall be graded and compacted in accordance with Section 31 23 16 “Excavation.” CONTRACTOR shall prepare the subgrade so that a minimum bearing capacity of 25 psi is provided in the limits of ballasted track. Subgrade geotextile for use in track subgrade stabilization may be used to achieve minimum bearing capacity requirements at locations to be determined in the field. Geotextile material properties and placement shall conform to the requirements established in Section 31 05 19 “Geotextiles” and 31 05 21 “Geogrids and Geocomposites.”

B. Spreading of Material:

1. Subballast aggregate shall be delivered to the site as a uniform mixture and shall be spread in layers without segregation. The material shall be free from pockets of large and fine material and shall be re-mixed until aggregate is uniform.

2. Subballast layers 6 inches or less in thickness shall be spread and compacted in one layer. For thicknesses greater than 6 inches, the subballast shall be spread and compacted in two or more layers of uniform thickness not greater than 6 inches each.

3. Subballast shall be conditioned prior to placement to optimum moisture content.

C. Compaction:

1. Compaction of the spread subballast layer shall be performed by means of a self-propelled type pneumatic-tire roller or a dynamic vibratory-type compactor.

2. Compaction of each layer shall continue until the material complies with the compaction acceptance testing requirements. The in-place dry density of each compacted layer shall be determined by the selected testing method and only one method shall be used throughout the remaining subballast testing. Compact subballast to 95% of maximum density as determined by ASTM D1557 and maintain moisture content within 2% of the optimum moisture content.

3. The thickness of finished subballast course shall not vary more than one inch from the indicated thickness at any point. The layer shall be re-shaped or re-worked, watered, and re-compacted to achieve compliance as required.

4. The surface of the finished subballast course shall not vary more than ½ inch above or 1 inch below the indicated finished grade.

3.3 BALLAST PLACEMENT

A. Handling:

1. Ballast delivered to the site shall be handled in such a manner that it is kept clean and free from segregation.

B. Initial Ballast Layer Placement:

1. An initial layer of ballast shall be uniformly distributed over the prepared subballast to the designated template and grades shown on the Design Drawings and thoroughly compacted before concrete tie placement operations.

2. The initial layer of the ballast shall be limited to the total compacted depth that will establish the track surface at least 2 inches below finished grade.

3. Each lift of ballast within the initial layer shall be uniformly spread and consolidated with not less than four passes of either a self-propelled pneumatic-tired roller or vibratory compactor. Each compacted lift within the initial layer shall not exceed a depth of 4 inches.

3.4 TRACK ALIGNMENT AND GEOMETRY

A. General: The track shall be constructed to the alignment and profile indicated, within the tolerances specified.

B. Profile Rail: The CONTRACTOR shall designate right or left rail, while facing in the direction of increasing stationing, to control the grade of all tangent tracks on a Contract-wide basis. The low or inner rail on all curves shall be used to control grade.

C. Line Rail: The CONTRACTOR shall designate right or left rail, while facing in the direction of increasing stationing, to control the alignment of all tangent tracks on a Contract-wide basis. On curves, the outside rail shall be designated the line rail.

D. Maintain monuments for the duration of the Work. Maintain an accurate surveyor's field book, accessible by the ENGINEER at any time, indicating all checks of the trackwork alignment. Record deviations from the design alignment that are accepted by the ENGINEER.

3.5 TRACK CONSTRUCTION

A. Tie Spacing:

1. Distance between centerline on adjacent ties shall not vary more than plus or minus one inch from the indicated spacing.

2. Unless otherwise shown on the Contract Drawings, concrete crossties in mainline track shall be spaced 30 inches on centers in tangent track and in curves with radii greater than 1000 feet. Concrete crossties in mainline track shall be spaced 27 inches on center in curves with radii less than 1000 feet.

3. Ties shall not be placed closer than three inches from any field rail weld. The juncture of two rails shall not occur over a wood tie for conventional bolted track and the ends of continuous welded rail (CWR) shall not occur over a concrete tie.

B. Placement of Ties:

1. The designated ties (standard) shall be distributed and properly spaced on the initial layer of ballast. Ties shall be laid equally offset to the centerline of track, and to the spacing designated on the Design Drawings and these specifications.

2. Unnecessary handling, redistribution, and reloading of ties shall be avoided. Ties shall be lifted and supported during storage and handling in such a manner as to prevent damage. Any ties damaged as a result of improper handling shall be rejected and replaced with undamaged ties. Cosmetic damages, cracking or chipping within allowable tolerances, shall be repaired by an appropriate procedure subject to statement of no objection by UTA. Allowable tolerances and the required repair protocol are outlined in Paragraph 2.2 A.5 and Paragraph 2.2 A.6 of Section 34 11 35 “Concrete Ties.”

C. Laying Rail:

1. Rail shall be welded in strings in advance by the flash butt welding process or field welded, placed and clipped onto the ties before dumping final ballast. Rail shall not be dragged over the fastener seats. Fastener seats shall be cleaned and prepared, so as to remove all loose foreign material, for placement of the rail pads and rail.

2. Final rail dressing and anchoring of ballasted track shall proceed when the track has been completely ballasted to prevent tie movements due to thermal expansion or contraction and when the track has been lifted, tamped, lined, and rail clips and fasteners have been cleaned.

D. Surfacing and Aligning:

1. After the skeleton track has been installed, ballast shall be placed in the tie cribs and shoulders of the track structure to restrain movement of the ties due to temperature changes in the rail.

2. Ballast shall be unloaded in quantities which shall fill the tie cribs and provide an adequate amount of ballast for the initial lift, and a surplus to continue to hold the track after the lift.

3. Track surfacing shall be performed by methods which shall prevent undue bending of the rail, straining of the joints, and damaging the tie shoulders and clips.

4. The amount of track lift shall not exceed 4 inches and shall not impact the horizontal and vertical stability of the track. The track shall be raised so that the final raise shall not exceed 3 inches when bringing the track to the final surface level.

5. After the track has been lifted, aligned and swept, the rails shall be anchored within the specified zero thermal stress range. Rail destressing activities shall conform to the requirements established in Article 3.9 D of Section 34 11 25 “Embedded Track Construction.”

6. Tamping shall be performed with a squeeze-vibratory type power tamper subject to UTA's written statement of no objection. Control of the power tamper's tamping cycle shall ensure the maximum uniform compaction of ballast along the track. The ballast shall be tamped on both ends of the ties from points 15 inches inside the rail centers to the ends of the ties, with a minimum of 2 cycles of the tamping machine. Tamping shall not be permitted at the center of the tie outside of the above-stated limits, but the cribs shall be filled with ballast in this area. For each tie, tamping shall proceed simultaneously inside and outside both running rails on both sides of the tie.

7. After final surfacing and alignment of track has been completed, the ballast shall be dressed to conform to the track typical sections designated on the Design Drawings. Place the top of ballast 1 inch, minimum, below the base of the running rail.

E. Rail Grinding:

1. Upon completion of the ballasted track installation to within the specified tolerances, but prior to its final acceptance, use a rail mounted grinder to touch up all running rail surfaces by contour grinding the curved contour of the rail head to provide similar head configurations and radii.

   a. Remove all rust, mill scale, and surface irregularities with successive passes of the rail mounted grinder. Lightly grind the top and gauge side corner of the running rail head as to limit nominal metal removal to 1/32 inch. Grinding shall not alter the as-rolled rail head contour and radii. Residual surface grinding & machining marks shall not be deeper than 0.010 inch.

   b. Rail grinder shall be a machine with not fewer than four grinding stones. The grinding wheels shall not be less than 10 inches in diameter and shall have controlled downward pressure to permit grinding more metal per pass at high spots and bridging at low spots less than 10 inches in length. Submit the type of rail grinding equipment and method of operation to the Resident Engineer for acceptance prior to initiation of rail grinding.

   c. CONTRACTOR shall detail how many passes he intends to do, what type of stones for initial and fine grinding he will use and with what speed he is going to proceed. CONTRACTOR shall submit from at least one former project he successfully completed with references work done and specifications for the submitted project.

   d. Grinding of the rail head to remove mill scale and surface irregularities may be undertaken at the rolling mill, subject to acceptance of the procedure by the ENGINEER. Post-installation field grinding to remove subsequent rail head surface oxidation may still be required.

2. Remove all filings due to grinding throughout the entire trackway using a vacuum process.

F. Final Track Inspection:

1. In order to determine the acceptability of all finished track, immediately after grinding the rail heads, inspect the trackwork in accordance with the approved Equipment and Inspection plan to establish that the track construction is within the tolerances specified.

2. Submit test results of the track geometry inspection in a format that will readily allow the identification and location of track defects. Use stationing identical to that shown on the Plans and provide a Track Inspection Car strip chart and printout report from the independent testing agency that indicate defects and exceptions discovered in the trackwork by the final track inspection.

END OF SECTION

SECTION 34 11 31

LRT – SUBBALLAST

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. The work in this Section covers the furnishing, placing, and compaction of subballast on prepared subgrade, to conform to the finish grades and sections shown on the Contract Drawings or established by the ENGINEER.

1.2 RELATED SECTIONS:

31 23 16 – Excavation

34 11 32 – Ballast

34 11 27 – Ballasted Track Construction

1.3 REFERENCES

Sponsor	Number	Subject
AREMA	Chapter 1 Part 2.11	Subballast and Specifications
UDOT	02721	Untreated Base Course
AASHTO	T2	Sampling
AASHTO	T 11	Materials Passing No. 200 Sieve
AASHTO	T 27	Sieve Analysis
AASHTO	T 96	Abrasion Testing
AASHTO	T104	Soundness
AASHTO	T112	Friable Particles
AASHTO	T113	Lightweight Pieces
AASHTO	T176	Sand Equivalent
AASHTO	T191 & T205	Density Testing
ASTM	C136	Sieve Analysis of Fine and Course Aggregate
ASTM	C698-78	Maximum Density Analysis

ASTM	D1140	Test for Amount of Materials in Soils Finer Than the No. 200 Sieve
ASTM	D1157	Moisture Density Relations of Soils and Soil Aggregate mixtures using 4.5 Kg rammer and 457 mm drop.

1.4 SUBMITTALS

A. Submittals shall be made in accordance with the General Conditions, except as modified herein.

B. Submit a written job-mix gradation for approval before production, including single values for each sieve size based on the dry weight of the aggregate.

C. The CONTRACTOR shall furnish samples of the material proposed for use as subballast and identification of material source sufficiently in advance to obtain approval by the ENGINEER not less than 30 days prior to anticipated date of commencing installation.

1.5 QUALITY ASSURANCE

A. Source of Materials:

1. Obtain approval of subballast by the ENGINEER prior to commencing installation.

2. Material or source of supply shall not be changed without approval of the ENGINEER.

3. Acceptance of subballast will be based on periodic samples taken following mixing.

B. Inspection:

1. The ENGINEER may stop delivery of material to the job site based on visual inspection pending sampling and testing.

2. If material loaded, being loaded or installed does not conform to specified requirements, the ENGINEER will reject the material and no further delivery will be accepted until the deficiency is corrected.

3. Unless otherwise permitted by the ENGINEER, remove rejected materials from the site within 48 hours of rejection. Materials shall be removed at CONTRACTOR’s expense.

4. Compaction will be subject to the tests specified herein.

C. Allowable Tolerances:

1. Construct subballast to the following tolerances:

a. Vertical: Within +1/2 inch or -1 inch of elevation shown. Deviation not to exceed 1/4 inch in 16 feet.

b. Horizontal: Within +3 inches or 0 inch of the limits shown.

2. During compaction maintain moisture content within 2% of optimum moisture content.

3. The material shall be placed in layers of three to six inches (or as directed by Construction Manager) and compacted to depth and density as required by the Contract Drawings and Specifications.

4. Thickness: Within minus 1/2 inch.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 – PRODUCTS

2.1 SUBBALLAST

A. Subballast shall be natural or crushed rock or gravel which conforms to the requirements of Utah Department of Transportation (UDOT) latest revision Standard Specifications Section 02721, except as modified herein.

B. Furnish crushed stone, crushed gravel, or natural gravel with the following requirements:

1. Subballast shall consist of crushed stone, crushed gravel, or natural gravel.

2. Subballast shall be free from flat, elongated, soft or disintegrated pieces, vegetable material or other deleterious matter occurring in a free state or as a coating on the stone. Reference recommended practice in AREMA Chapter 1, Part 2, Section 2.10.3(f).

3. Gradation: ASTM C136 and C117 per the following table. Reference recommended practice in AREMA Chapter 1, Part 2, Section 2.11.2.5 and Chapter 18, Part 2, Table 18.1.1.

4. Clay lumps and friable particles, in accordance with ASTM C142 and recommended practice in AREMA Chapter 1, Part 2 Section 2.4.1.5: 0.5 percent maximum.

5. The liquid limit shall be not greater than 30 and the plasticity index shall not exceed six when tested in accordance with ASTM D4318 and T90 respectively.

6. The source material from which the subballast is produced shall not have a percentage of wear greater than 30 percent when tested by the Los Angeles wear test (AASHTO T96).

7. Shipments of subballast not conforming to this section shall be rejected at the Contractor's expense.

C. Grading Requirements:

1. The subballast shall be graded from coarse to fine and shall conform to the requirements of UDOT Standard Specifications Section 02721-2.1 B. Table 2 for 1-1/2" base aggregate.

PART 3 – EXECUTION

3.1 PLACEMENT

A. Prior to the CONTRACTOR beginning work to install subballast, the ENGINEER and the CONTRACTOR shall make a joint inspection of the trackway subgrade for acceptance.

B. All unacceptable areas of subgrade shall be repaired. All work shall conform with the requirements of Section 31 23 16 “Excavation.”

C. Prior to the placement of subballast material, the surface of the trackway subgrade stabilization layer shall be graded as required to comply with Section 31 23 16 “Excavation”. Placement of subballast material shall conform to the requirements of this Section 34 11 27 – Ballasted Track Construction, except as modified herein.

D. Do not place material on subgrade that is muddy, rutted, frozen, or has standing water.

E. Place layers in equal thickness and compact each layer to a thickness not to exceed 6 inches in depth.

3.2 COMPACTION

A. During placing and compacting, maintain moisture content within specified tolerance in this section.

B. Compact each layer to a density of not less than 90% of the maximum density determined in accordance with ASTM D1557.

C. The surface of each layer shall be maintained during the compaction so that a uniform texture is produced, and the aggregates are firmly keyed.

3.3 TESTING

A. Testing shall be performed by the approved testing lab selected and managed in accordance with the General Conditions. Quality assurance tests may be performed by the ENIGNEER to ensure compliance with this Specification.

B. In-place density will be determined in accordance with AASHTO T 191, T 205 and T 238. Testing will be performed every 200 lineal feet of route. In addition to density testing, or in lieu of as the ENGINEER elects, each compacted layer will be observed for deflection or reaction under moving loaded equipment to verify that no soft or pumping areas remain in any layer or foundation soil.

C. Compaction required will be 95-percent in accordance with ASTM D 1557.

D. Gradation testing shall be performed on every 500 tons of delivered Material and in accordance with the requirements of AASHTO T 27.

3.4 CARE OF WORK

A. Following installation of the subballast, the CONTRACTOR shall do such work as the ENGINEER determines necessary to prevent or repair segregation, raveling and other damage or displacement, regardless of the cause, and to maintain the layer to specified condition until it is covered with a following layer to specified condition or course or until all Contract work is completed. Prevention may include, as determined by the ENGINEER, prohibiting or limiting construction traffic from the prepared subballast surface. Materials no longer meeting Paragraphs 2.1.A and B of this Section shall be removed from the job site and replaced by the CONTRACTOR at no expense to the UTA.

B. After acceptance by the ENGINEER, the CONTRACTOR becomes responsible for all future repairs necessary to the subballast until the project is completed. No additional payment will be made for future repairs to subballast.

C. The CONTRACTOR shall not proceed with the distribution and placement of any materials such as ballast, crossties, rail or other track material on the prepared subballast surface until the prepared subballast surface has been accepted by the ENGINEER subsequent to a joint inspection by the CONTRACTOR and the ENGINEER.

END OF SECTION

SECTION 34 11 32

LRT – BALLAST

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. This Section specifies the furnishing and installation of mineral aggregate for ballast on top of constructed subballast as shown on the Contract Drawings and as specified herein.

B. Related Requirements:

1. Section 34 11 31 – Subballast
2. Section 34 11 27 T – Ballasted Track Construction

1.2 RELATED SECTIONS

34 11 31 – Subballast

34 11 27 – Ballasted Track Construction

1.3 REFERENCES

Sponsor	Number	Subject
AREMA	Chapter 1 Part 2	Ballast
ASTM	C 29	Test Method for Unit Weight and Voids in Aggregate
ASTM	C 88	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM	C 117	Test Method for Material Finer Than No. 200 Sieve in Mineral Aggregates by Washing
ASTM	C 127	Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM	C 136	Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM	C 142	Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM	C 535	Test Method for Resistance to Degradation of Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM	C 702	Method for Reducing Field Samples of Aggregate to Testing Size

ASTM	D 75	Practices for Sampling Aggregates
ASTM	D 4791	Standard Test Method for Flat or Elongated Particles in Coarse Aggregate

1.4 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein.

B. Identification of testing service, their testing program, and copy of their agreement with CONTRACTOR.

C. Testing laboratory test report.

D. Quarry qualification test report.

E. Plan for handling and placing ballast.

1.5 QUALITY ASSURANCE

A. All laboratory testing shall be carried out as specified in the General Provisions at the expense of the CONTRACTOR. The testing service and their testing program and procedures shall be subject to the approval of the ENGINEER.

B. The CONTRACTOR shall submit a copy of his agreement with the Independent Testing Laboratory to the ENGINEER for approval. The agreement shall specify that the testing agency is directly responsible to the ENGINEER, that all subsequent communication between the testing services and the CONTRACTOR regarding the work under this contract shall only be through the ENGINEER, and that the agreement shall run for the duration of the contract and can only be terminated by the ENGINEER.

C. The Independent Testing Laboratory shall submit timely, professional test reports containing a description of each test, identification of test equipment along with current calibration certificates, an explanation of all deviations of test procedures, tabulations and/or plots of test results, the testing service's evaluation of the results, and sketches or diagrams necessary to clarify the test or results.

D. The Independent Testing Laboratory shall submit five copies of each test report to the ENGINEER. The ENGINEER will forward two copies to the CONTRACTOR.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General: Ballast shall be quarried crushed rock with fractured faces composed of hard, strong and durable particles, free from injurious amounts of deleterious substances and conforming to the requirements of the following paragraphs.

B. Ballast Source: The CONTRACTOR shall select his ballast source to produce ballast in accordance with these Specifications. Do not change material or source of supply without prior approval of the ENGINEER.

C. Ballast material shall be the following:

1. With Concrete Cross Ties – Granite or Traprock.

2. With Timber Cross Ties – Granite, Traprock, Quartzite or Carbonate.

3. For TPSS sites – Granite, Traprock, or Quartzite.

4. With composite ties – Granite, Traprock, Quartzite, or Carbonate

D. Quality:

1. Deleterious material in the ballast shall not exceed the following amounts, as determined by the appropriate testing method listed:

Minus 200 Sieve	1.0 Percent Maximum per ASTM C 117
Clay Lumps	0.5 Percent Maximum per ASTM C 142

2. Wear of the material shall not exceed 28 percent when tested in accordance with ASTM C 535.

3. Loss shall not exceed 5 percent after 5 cycles when tested in accordance with ASTM C 88 for sodium sulfate soundness.

4. Absorption shall not exceed 2.0 percent in accordance with ASTM C 127.

5. Flat and elongated particles are not to exceed a weighted average of 5 percent by weight, as determined by ASTM D 4791.

6. Use of limestone, slag, river gravel or any material containing metallic ore or metallic residues is prohibited.

7. Sampling shall be done in accordance with ASTM D 75. Test samples shall be reduced from field samples by means of ASTM C 702.

8. Determination of weight per cubic yard shall be in accordance with ASTM C 29.

E. Gradation Requirements:

1. Gradation of ballast shall be determined by testing in accordance with ASTM C 136. All gradation tests shall include minus 200 sieve particle analysis in accordance with ASTM C 117.

2. Ballast to be installed in track shall conform to AREMA No. 4A gradation table 1-2-2 Recommended Ballast Gradations.

3. Gradation: ASTM C136 and C117 and AREMA Chapter 18, Part 2, Table 18-1-1 with the following additional requirements:

    a. Mainline Track: AREMA Size 4.

    b. Paved Track: AREMA Size 5.

    c. TPSS Sites: AREMA Size 4.

PART 3 – EXECUTION

3.1 HANDLING

A. Ballast shall be kept clean and free from segregation during handling and placing operations. The CONTRACTOR shall submit his plan for handling and placing ballast. This plan shall include source, type of equipment to be used, location of stockpiles and method of distribution. Storage sites for ballast are the complete responsibility of the CONTRACTOR. Care must be taken in retrieving material from stockpiles to avoid contamination with the underlying materials and segregation.

3.2 DELIVERY TICKETS

A. In accordance with AREMA Chapter 1, Part 2, Section 2.8 (2 gradation test for every 1,000 tons).

B. Additional sampling and testing shall be performed if in the Construction Manager’s opinion, there are significant changes in the quarry operation.

C. Maintain records of delivery tickets and provide to the Construction Manager or RTD upon request.

D. Each delivery ticket shall include at least the following information:

1. Plant or point of loading and date and time of loading.

2. Truck or other container serial number or similar description.

3. Truck or other container empty weight. This weight shall be taken daily and shall include the operator and a reasonable amount of fuel so that the empty weight shall be a reasonable average weight for the day.

4. Truck or other container weight after loading.

5. The ballast weight in net tons, developed by subtracting Number 3 from Number 4 above.

6. Type of material and source location.

3.3 INSTALLATION

A. Ballast shall be placed, spread, compacted, tamped and dressed in accordance with Section 34 11 27 “Ballasted Track Construction.” Ballast shall not be placed, spread, compacted, tamped and dressed until the subballast surface has been accepted by the ENGINEER subsequent to a joint inspection by the CONTRACTOR and the ENGINEER.

3.4 INSPECTION

A. Ballast is subject to inspection and testing (gradation and quality) as often as considered necessary by the ENGINEER. Ballast which does not conform to this Specification shall not be used and the ENGINEER will notify the CONTRACTOR to stop further ballast operations. Ballast operations shall not resume until the fault has been corrected and defective material has been disposed of by the CONTRACTOR without cost to UTA.

B. Make provisions for the ENGINEER to have free entry to the producing plants at all times while the work of this Contract is being executed.

C. Provide the ENGINEER all reasonable facilities to ensure that the ballast is being prepared and loaded in accordance with the specifications.

D. Ballast samples will be collected at the point where the contractor takes ownership of the material.

3.5 TESTING

A. Qualification Testing:

1. Ballast at the quarry shall be qualified prior to production. The CONTRACTOR shall have representative samples taken, tested for quality and gradation and certified by the approved testing laboratory.

2. Each stratum or portion of the quarry containing a variation in quality of stone shall be tested. Tests of a single stratum or portion shall not be averaged with any other stratum or portion of the quarry. Two samples shall be taken from each ledge or different quality of stone used in the preparation of the ballast.

3. Certificates shall be submitted not less than five (5) working days prior to start of production of ballast. Additional sampling and testing shall be performed if, in the ENGINEER’s opinion, there are significant changes in the quarry operation.

B. Quality Control Testing:

1. The approved testing lab will sample ballast and perform a minimum of one gradation test for every 1,000 cubic yards of ballast delivered to the job site to ensure uniformity and conformance with the gradation requirements. The test results will be submitted for the ENGINEER’s approval within two (2) days of the time the test was performed.

2. Soundness tests will be performed in accordance with ASTM C 88 as required.

3.6 DEFECTIVE MATERIALS

A. Unless otherwise permitted by the ENGINEER, the CONTRACTOR shall remove rejected materials from the site within 48 hours of rejection. Materials shall be removed and replaced at CONTRACTOR's expense.

END OF SECTION

SECTION 34 11 34

LRT – STANDARD AND HIGH STRENGTH RAIL

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. This Specification defines the requirements for the manufacture, supply, testing, and delivery of standard rail and high strength rail.

2. CONTRACTOR shall furnish standard and high strength running rails in 80 ft. length. Standard Rail (Surface Brinnell hardness -310 HB) shall be used for mainline tangent track and for curve track with radii greater than 900 ft. High Strength Rails (Surface Brinnell hardness -370 HB) shall be used for Station platform tracks, for curved track with radii equal to or less than 900 ft., and for restraining rail as specified herein, as shown on the drawings and in Section 34 11 33 “Special Trackwork.”

3. CONTRACTOR shall pre-weld the rail strings as required using the flashbutt weld process for the standard and high strength rail. CONTRACTOR shall field weld rail strings as specified in section 34 11 25 “Embedded Track Construction.” High Strength running rail and restraining rail for curved track with radii equal to or less than 300' CONTRACTOR shall pre-curve and shall shop fabricate as specified in Section 34 11 33 “Special Trackwork.”

4. CONTRACTOR will be responsible for the in-line weld testing of all laid rail according to Section 34 11 47 “Trackwork – Rail Handling, Plant Welding and Storage.”

1.2 RELATED SECTIONS

34 11 33 – Special Trackwork

34 11 25 – Embedded Track Construction

34 11 47 – Trackwork – Rail Handling, Plant Welding and Storage

1.3 REFERENCES

Sponsor	Number	Subject
AREMA	Chapter 4	Rail
ASTM	E8/E8M-08	Standard Test Methods for Tension Testing of Metallic Materials
ASTM	E10-07a	Standard Test Method for Brinell Hardness of Metallic Materials
ASTM	E428-05a	Standard Practice for Fabrication and Control of Metal, Other than Aluminum Reference, Blocks used in Ultrasonic Examination
ASTM	A370-07a	Standard Test Methods and Definitions for Mechanical Testing of Steel Products

1.4 SUBMITTALS

A. CONTRACTOR shall provide the following in compliance with requirements of the General Provisions, and with the additional requirements as specified for each:

1. Detailed description of the steel metallurgy and the identity of each rail provided by heat ingot and letter.

2. A detailed description of the methods and procedures to be used to remove hydrogen in the steel.

3. A description of the ultrasonic testing method and equipment together with mill test report certificates of rails tested for this order.

4. A description of the method and verification testing to achieve the required rail hardness together with reports indicating the actual hardness achieved.

5. Quality Control Program description by the plant supplier of the rail.

6. Method of handling, shipping, unloading, and stacking rail from the time it is loaded onto the transporting vehicles at the rolling mill until it is to be stockpiled. This includes the method of dunnage support for rails and the stocking sequence for standard, high strength and pre-curved rail for mainline.

7. Rail processing reports and a rail list showing the heat, ingot and letter for every rolled rail including identification of the short rail, test rail, scrap rail, and similar information for informal review during the in-plant inspection in addition to formal submittal.

8. Rail test records, including mechanical properties tests, hardness measurements, ultrasonic test records and all other required test documentation, for informal review during the in-plant inspection in addition to formal submittal.

9. Ultrasonic Inspector’s qualification certification for the individuals actually conducting the testing at least 30 days before the commencement of the in-plant inspection.

10. Hardness and mechanical properties of rails previously supplied to and accepted by others that were similar to the rails required under this Contract.

1.5 QUALITY ASSURANCE

A. The CONTRACTOR shall appoint a qualified QA representative(s) for inspecting the test reports and rail products supplied by the CONTRACTOR. All costs of such inspection shall be paid by the CONTRACTOR.

1.6 ACCEPTANCE

A. Not applicable.

PART 2 – PRODUCTS

2.1 RAIL

A. All new rail supplied by the contractor shall be 115 RE section conforming to Standard AREMA Chemistry Steel Rail with standard or high strength property conforming to the requirements of the following sections of the current edition of AREMA Manual for Railway Engineering, Chapter 4:

1. Part 1 - Design (Rail section design for 115 RE Rail)

2. Part 2 – Manufacture of Rail, Section 2.1.4.1 Specifications for Standard AREMA Chemistry Rail.

B. All rail shall be furnished with blank ends.

C. Rail shall be in 78-80-82 foot lengths at a temperature of 600 F.

D. A maximum of 10 percent of the rails of each type may be short lengths.

1. Allowable short lengths for the 78 to 82-foot rail lengths are 77, 76, 75 and 70 feet.

E. Tolerances of rail shall conform to AREMA Specifications for Steel Rails.

2.2 CHEMICAL COMPOSITION

A. The chemical composition of the high strength rail shall be within the following limits per the current edition of AREMA Manual for Railway Engineering, Chapter 4, Part 2, Section 2.1.

1. CONTRACTOR shall furnish a complete report of the ladle analysis of each heat.

2. CONTRACTOR shall furnish drillings from the test samples for check analysis by an independent testing agency.

2.3 SURFACE HARDNESS PROPERTIES

A. Rail surface hardness shall be in accordance with the current edition of AREMA Manual for Railway Engineering Chapter 4, Part 2, Section 2.1.3.2. High strength rails shall be produced with a minimum hardness limit of Brinell 370.

B. A Brinell hardness test shall be performed in accordance with the current edition of AREMA Manual for Railway Engineering Chapter 4, Part 2, Section 2.1.3.2.

2.4 MECHANICAL/TENSILE PROPERTIES

A. High Strength rail tensile properties shall be in accordance with the current edition of AREMA Manual for Railway Engineering Chapter 4, Part 2, Section 2.1.3.4.

2.5 ROLLING

A. The finished rail section shall be in accordance with the current edition of AREMA Manual for Railway Engineering 115RE rail section and subject to the following tolerances in accordance with Chapter 4, Part 2, Table 4-2-2.

2.6 BRANDING AND STAMPING

A. Branding and stamping shall be in accordance with Section 2.1.6 “Branding and Stamping” of the current edition of AREMA Manual for Railway Engineering.

2.7 TESTING FOR INTERIOR CONDITIONS

A. Rail shall meet the requirements of ASTM E428-05a. All rail shall be ultrasonically tested for internal imperfections in accordance with the current edition of AREMA Manual for Railway Engineering, Chapter 4, Part 2, Section 2.1.8.

2.8 CLASSIFICATION

A. Rail classification shall be in accordance with Section 2.1.10 “Surface Classification” of the current edition of AREMA Manual for Railway Engineering, Chapter 4.

2.9 STRAIGHTNESS

A. Rail straightness shall conform to the current edition of AREMA Manual for Railway Engineering Chapter 4, Part 2, Section 2.1.13.1.

2.10 FINISH

A. Rail ends shall be hot sawed, cold sawed or milled square at the ends. A variation of not more than 1/32 inch in end squareness will be allowed. Rail end faces should be smooth and within 1/32 inch to ensure proper surface contact for welding.

2.11 MARKINGS

A. Rail markings shall be in accordance with Section 2.1.15 “Markings” of the current edition of AREMA Manual for Railway Engineering, Chapter 4.

PART 3 – EXECUTION

3.1 HANDLING AND STORAGE

A. CONTRACTOR shall notify UTA where the rail will be stored.

B. CONTRACTOR shall be responsible for picking the rail up from the storage location and hauling rail to the construction site. CONTRACTOR shall abide to the following:

1. Abide by all local traffic ordinances and regulations, and protect the public and workers by complying with the requirements of an applicable traffic barricade manual.

2. Load, transport, unload, store and handle rail so as to prevent damage.

3. Load, unload, handle and store rail by accepted methods to prevent kinking, bending, nicking, or otherwise damaging the rail.

4. In unloading operations, place length of rail with the head up, without dropping, and with sufficient support under the base.

5. Do not subject individual rails and rail bundles to excessive static loading.
6. Avoid sudden impact or dynamic loading, and prevent high stressing arising from point or line loading.
7. Spanner beams are recommended.
8. Single point slinging of rail is prohibited.
9. Avoid excess cantilever of the rail end beyond the slinging points in order to prevent permanent bending and excessive stressing of the rail.
10. Locate slinging points at uniform lengths along the load so that rails are in a horizontal position at all times.
11. Any rail support, handling, clamping or pinch rollers must be contoured properly to match the particular rail profile and thus avoid localized point or line contact.
12. Use only slings that do not cause surface damage or notching. Terylene or nylon strapping is recommended, with an additional sleeve where the sling is in contact with the rail. Flat profile chain link slings with a protective sleeve are also recommended.
13. The use of chains and wires that may cause surface damage are not allowed.
14. Use sufficient timber dunnages at all times, and take particular care when extracting slings from around rail lifts in order to ensure they are not ripped out.

END OF SECTION

SECTION 34 11 35 T

LRT – CONCRETE TIES

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. This Section defined the requirements for the design, manufacture, supply, inspection, testing, furnishing, packaging, handling, loading, shipment, delivery, unloading, and stockpiling of standard concrete ties.

2. This Section defines the requirements for the design, manufacture, supply, inspection, testing, furnishing, packaging, handling, loading, shipment, delivery, unloading, and stockpiling of concrete ties for restraining rail, including installation of the fastening system for securing the running rails and restraining rail.

3. This Section also defines the requirements for the design, manufacture, supply, inspection, testing, furnishing, packaging, handling, loading, shipment, delivery, unloading, and stockpiling of 10’-0” long concrete ties to be used at transitions between dissimilar track types.

4. Pre-cast concrete monoblock ties shall be designed, manufactured, supplied, inspected, tested, furnished, packaged, handled, loaded, shipped, delivered, unloaded, and stockpiled in accordance with current requirements of AREMA, Manual for Railway Engineering, Chapter 30, Part 4 “Specifications for Concrete Ties”, except as modified herein.

1.2 RELATED SECTIONS

03 30 00 – Cast in Place Concrete

34 11 27 – Ballasted Track Construction

34 11 38 – Rail Clips and Cast Shoulders

1.3 REFERENCES

Sponsor	Number	Subject
AREMA	Chapter 30 Part 4	Concrete Ties
ASTM	A421/A421M-05	Standard Specification for Uncoated Stress-Relieved Wire for Prestressed Concrete
ASTM	A881/A881M-05	Standard Specification for Steel Wire, Deformed, Stress-Relieved or Low-Relaxation for Prestressed Concrete Railroad Ties

ASTM	A416/A416M-06	Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
ASTM	A886/A886M-05	Standard Specification for Steel Strand, Indented Seven-Wire Stress Relieved for Prestressed Concrete
ASTM	C33-07	Standard Specification for Concrete Aggregates
ASTM	C150-07	Standard Specification for Portland Cement
PCI	MNL-116-99	Manual for Quality Control for Plants and Production of Structural Precast Concrete Products
ASTM	C494/C494M-08	Standard Specification for Chemical Admixtures for Concrete
ACI	318-05	Building Code Requirements for Structural Concrete and Commentary
PCI	MNL-135-00	Tolerance Manual for Precast and Prestressed Concrete Construction
ASTM	C31/C31M-08	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM	A615/A615M-07	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM	A996/A996M-06a	Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM	A184/A184M-06	Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM	A82/A82M-07	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM	A185/A185M-07	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM	A496/A496M-07	Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM	C359-07	Standard Test Method for Early Stiffening of Hydraulic Cement (Mortar Method)
ASTM	C260-06	Standard Specification for Air-Entraining Admixtures for Concrete

1.4 SUBMITTALS

A. CONTRACTOR Submittals for Standard Concrete Ties:

1. Concrete 8500 psi after 28 days.

2. Prestressing strands nominal 0.207 diameter, wire grade 260 ksi.

3. Concrete tie drawing (included in contract documents).

4. The tie was designed and manufactured in accordance with the technical specifications of AREMA, Chapter 30 for pre-stressed concrete ties.

5. Pads, shoulder inserts and fast clips pre-assembled on tie. Clips, insulators and shoulder types listed on drawings.

6. Longitudinal rail restraint.

7. Electrical properties.

8. Test results of procured ties by UTA.

9. Tolerances ties were manufactured to submittals made to UTA from tie manufacturer Rocla or approved equal.

B. CONTRACTOR Submittals for Special Concrete Ties:

1. Inspection and Test Plan and Procedures.

2. Delivery Procedures.

3. Physical configuration of the proposed 10’-0” long concrete transition ties including all critical dimensions.

4. List of references and contact personnel of transit authorities that have qualified and accepted similar 10’-0” long concrete transition ties for Contracts with similar technical specifications.

5. Statement of the manufacturer’s capabilities to carry out the work in accordance with the technical and quality assurance/control requirements.

6. Testing facilities certifications.

1.5 QUALITY ASSURANCE

A. Quality assurance/quality control shall be in accordance with the requirements of the General Provisions, and Part III of this Section.

B. The CONTRACTOR’s fabrication drawings and detailed calculations to support the Design Criteria as specified herein shall be reviewed per the General Provisions.

1.6 ACCEPTANCE

A. Not Applicable.

PART 2 – PRODUCTS

2.1 MAJOR COMPONENTS FOR STANDARD AND SPECIAL CONCRETE TIES

A. The major components of the precast concrete tie shall include the following:

B. Precast concrete tie of monoblock design provided with steel prestressing tendons and steel reinforcement as required by the UTA's design criteria specified herein.

C. Running rail fastening system, Pandrol FASTCLIP or approved equivalent, to support and transmit loads from the running rails into the precast concrete ties. The rail fastening system shall include embedded shoulders which shall be furnished by CONTRACTOR in accordance with Section 34 11 38 "Rail Clips and Cast Shoulders."

1. Basic Configuration:

a. The basic configuration, dimensions and tolerances of the precast concrete tie shall be as defined on the drawings and as defined below:

1) The rail seat shall provide for a cant of 1 in 40 +/− 5 toward the centerline of the precast concrete tie.

2) The rail seat shall be plane to a tolerance of +/− 1/32 inch for the portion directly under the rail.

3) The differential tilt in the direction of the rail of one rail seat to the other shall (on a width of 6 inches) not exceed 1/16 inch.

4) Long term vertical differential displacements of the center of the tie relative to the two rail seats, due to concrete creep and shrinkage, shall not exceed ⅛ inch downwards and 0 inches upwards.

2. Flexural Limits:

a. The precast concrete tie shall be designed to withstand the following minimum bending moments calculated for the maximum wheel loads based on the Normal and Ultimate Limit states without cracking:

1) Rail Seat Positive Moment 13.3 KFT

2) Negative Rail Seat Moment 7.4 KFT

3) Center Positive Moment 6.65 KFT

4) Center Negative Moment 10.33 KFT

b. In addition to the criteria specified herein, the precast concrete ties shall conform to the design practices specified in ACI 318, or approved equivalent.

2.2 MATERIALS

A. Concrete shall be in accordance with the current edition of AREMA Manual for Railway Engineering, Chapter 30, Section 4.2.2. All concrete shall be class 4A (AE) per Section 03 30 00 "Cast in Place Concrete." The test cylinders shall be made and stored in accordance with ASTM C31. At the same time pre-stressing is transferred into the concrete, the concrete strength shall not be less than 3,000 psi.

1. Cement:

    a. Cement shall be Portland cement conforming to the requirements of ASTM C150, or approved equal. Quantities given for proportioning shall be based on 120% of the required compressive strength. It is recommended that cement alkali content of Na2O equivalent be as low as possible and not greater than 0.6%. False set penetration when tested in accordance with ASTM C359 shall be not less than 50 mm initially, 35 mm at intermediate times and 40 mm after remix.

    b. The mix design shall specify the range of air content in the plastic concrete which has found to provide an air void content in the hardened concrete between 4.5% and 6%.

    c. Cement mill certificates should be obtained on a regular basis during tie production in order to ensure consistency in chemical ingredients. Under no circumstances shall substitution of cement be permitted unless it has been pre-qualified through all applicable tests.

2. Aggregate:

    a. Fine and course aggregate gradation shall conform to the requirements of the AREMA Specifications for Aggregates, Chapter 8, Concrete Structures and Foundations, Part 1, Materials, Tests and Construction Requirements, Section 1.4, Aggregates.

    b. Coarse aggregate gradation shall consist of gravel, crushed stone, or combinations thereof, and shall conform to ASTM C33, or approved equivalent. Coarse aggregate gradation shall be submitted with the CONTRACTOR’s drawings. The maximum size of coarse aggregate used shall be no larger than one-fifth of the narrowest dimension between forms of the member for which concrete is used, nor larger than one-half of the minimum clear space between reinforcing bars.

    c. All aggregates shall be obtained from a single source.

3. Admixtures:

    a. Admixtures shall conform to ASTM C494 and shall not contain chlorides, fluorides, sulfates, nitrates, or aluminum powder. An air entraining agent in accordance with ASTM C260 shall be used since the ties will be exposed to freeze-thaw conditions.

    b. Water used in mixing concrete and washing aggregate shall be potable and free of injurious amounts of oil, acid, alkali, salt, sugar, vegetable matter or other deleterious substances that are potentially harmful to the concrete and reinforcing steel. In addition, it shall not contain deleterious amounts of chloride ion (i.e. any amount exceeding 400 ppm).

4. Curing:

a. Precast concrete ties should be cured by a method or procedure set forth in the PCI Manual for Quality Control (MNL116, latest edition) and modified per Section 4.2.2.5 in the current edition of AREMA Manual for Railway Engineering.

5. Surface Finish:

a. The top and side surfaces of each precast concrete tie shall present a smooth, uniform appearance. Heavy concentrations of surface voids or evidence of improper mixing, vibration, or curing will be a cause for rejection.

b. The bottom surface shall present a rough finish, as struck with a wood screed. Projections and indentations in the surface shall not exceed ¼ inch.

c. There shall be no evidence of tearing of the concrete where the prestressing strands emerge, or any void in contact with a reinforcing strand.

d. Air voids or water pockets shall not exceed four (4) percent of the top and side surface area. Precast concrete ties with voids greater than 1 ½ inches round and deeper than ½ inch will be rejected. Voids less than the above-defined dimensions shall be repaired with an approved grout.

e. Corner breakages less than the above-defined dimensions shall be repaired with grout.

6. Concrete Repair:

a. Filling in and repair of surface voids and minor damage in the concrete shall be made using a cementitious, non-shrink grout with a flowing consistency without bleeding or segregation. The grout shall have a minimum 28-day compressive strength of 8,000 psi.

b. The grout color shall match the color of the adjoining concrete being repaired.

c. The grout shall be applied uniformly to produce a smooth and even surface to match the contour of the adjoining concrete surface.

7. Identification:

a. Precast concrete ties shall be permanently labeled by indented or raised numerals or letters on the top surface at one end. The labeling shall identify the manufacturer, type of tie, form & cavity, year of manufacture, and date code as approved by the ENGINEER.

B. Metal reinforcement shall be in accordance with the current edition of AREMA Manual for Railway Engineering, Chapter 30, Section 4.2.4.

1. Prestressing Steel:

a. Strand for pretensioning tendons shall conform to ASTM A416 or ASTM A886, while wires for pretensioning tendons shall conform to ASTM A421 or ASTM A881, and as described below.

b. Prestressing steel shall be made from the same grade in all precast concrete ties and shall be protected against physical damage at all times.

c. Wire strands or wires shall be aligned to produce equal stress in all wires, wire strands or wire-strand groups which are to be stressed simultaneously, or when necessary to ensure proper positioning in the enclosure.

d. Prestressing steel and steel reinforcement shall be placed in precast concrete ties as indicated on the CONTRACTOR's drawings. Pre-tensioned steel shall be secured to retain full initial tension during placing and curing of concrete.

e. All prestressing steel and steel reinforcement shall be clean, free from oil, dirt or other foreign material potentially detrimental to bond prior to placement of concrete.

2. Prestressing Operations:

a. Prestressing steel and steel reinforcement shall be stored and handled in such a manner which will avoid bending, injury from deflection, scraping, corrosion, and overstressing of the steel.

b. Prestressing steel shall be tensioned by hydraulic jacks. Each jack shall be equipped with either a pressure gauge or a load cell for determining the jacking force. The pressure gauge, if used, shall have a dial at least 6 inches in diameter, and each jack shall be accurately calibrated to within one percent of full scale reading when the cylinder is extended to the approximate final jacking position. Calibration of each jack-gauge unit shall be repeated at intervals not exceeding 180 days. The gauge shall be accompanied by a certified calibration chart. During calibration, the gauge shall be checked against a master gauge, kept solely for checking purposes. The load cell, if used shall be calibrated and shall have an indicator by which the prestressing force in the tendon may be determined. The range of the load cell shall be such that the lower 10% of the manufacturer's rated capacity shall not be used in determining the jacking force.

c. Precast concrete ties in casting beds shall not be de-tensioned until the accelerated curing cycle has been completed and the enclosure and any other constraints have been removed. The temperature of the concrete shall be maintained at not less than 600 F, until the stress is transferred to the concrete.

d. Cutting and releasing of prestressing steel in pre-tensioned members shall be performed in an order so as to ensure that lateral eccentricity of prestress shall be eliminated or shall be minimized.

e. Transfer of force from bulkheads of the casting bed to the concrete shall be accomplished by gradual de-tensioning of all strands or wires.

f. The working force in the prestressing steel shall not be less than the calculated value. Unless otherwise indicated, the average working stress in the prestressing steel shall not exceed 60% of the specified minimum ultimate tensile strength of the prestressing steel. Working force and working stress shall be the force and stress remaining in the prestressing steel after all losses, including those of creep and shrinkage of concrete, elastic compression of concrete, relaxation of steel, losses in post-tensioned prestressing steel due to sequence of stressing, friction, take up of anchorages and other losses peculiar to the method and system of prestressing have taken place and have been considered.

3. Steel Reinforcement:

   a. Reinforcing bars shall conform to either ASTM A615 or A996, except that yield strength shall correspond to that determined by tests on full-size bars; and for reinforcing bars with a specified yield strength of the reinforcing steel, exceeding 60,000 psi, shall be the stress corresponding to a strain of 0.35%.

   b. Bar and rod mats for concrete reinforcement shall be the clipped type conforming to ASTM A184.

   c. Plain wire for spiral reinforcement shall conform to ASTM A82, except that fy shall be the stress corresponding to a strain of 0.35% if the yield strength specified in the design exceeds 60,000 psi.

   d. Welded plain wire fabric for concrete reinforcement shall conform to ASTM A185, except that welded intersections shall be spaced not farther apart than 12 inches in the direction of the principal reinforcement.

   e. Deformed wire for concrete reinforcement shall conform to ASTM A496, except that wire shall not be smaller than size D-4 and that fy shall be the stress corresponding to a strain of 0.35% if the yield strength specified in the design exceeds 60,000 psi.

   f. Welded deformed wire fabric for concrete reinforcement shall conform to ASTM A947, except that welded intersections shall be spaced not farther apart than 16 inches in the direction of the principal reinforcement.

   g. Steel reinforcement shall be tied with No. 16 wire so as to prevent displacement during pouring of concrete. Reinforcement shall be held in position by coated spacers, chairs, or other supports.

4. Cover:

   a. Pre-tensioning tendon ends shall not project more than ¼ inch beyond the ends of the ties, or as specified by the engineer. Post-tensioning tendon ends shall not protrude beyond the ends of the ties and shall be covered with concrete, epoxy grout or other material approved by the ENGINEER.

   b. The minimum concrete cover for reinforcement, prestressing tendons, ducts, or prestressing end fittings shall be ¾ inch, unless otherwise noted.

c. The tolerance for depth of placement for conventional reinforcing steel shall be +/− ⅛ inch. The tolerance for placement of prestressing steel shall be +/− ⅛ inch vertical and +/− ¼ inch horizontal. The tolerance for longitudinal location of bends in reinforcing bars shall be +/− 2 inches and the tolerance for the location of ends of reinforcing bars shall be +/− ½ inch.

5. Cast Shoulders:

a. The embedded shoulders of the rail fastener shall be positioned within a tolerance of +/− 1/32 inch of the design dimension required to provide the track gauge specified on the drawings. Embedded shoulders shall be positioned square to the tie both horizontally and vertically to a tolerance of +/− 1°. The shoulders shall be cast into all ties during the concrete molding process.

b. Cast shoulders shall be free of rust, mud, oil or other contamination. They shall be rigidly secured in the molds during casting and shall not move within the concrete when the securing device is released.

c. Longitudinal rail restraint performance requirements shall be such that the rail fastening assembly must have the ability to restrain 2.4 kips per tie, which shall be held for not less than 15 minutes. The rail shall not move more than 0.20 inch during the initial 3-minute period, and there shall be no more than 0.01-inch movement of the rail after the initial 3 minutes.

d. Lateral rail restraint performance requirements shall be such that track shall not experience gage widening of more than ¼ inch under test conditions.

PART 3 – EXECUTION

3.1 QUALIFICATION TESTING FOR STANDARD AND SPECIAL CONCRETE TIES

A. Prior to acceptance of precast tie design, the precast concrete ties shall be subjected to testing for compliance with these Specifications. Failure of the proposed design of the precast concrete ties to pass these tests shall require redesign and retesting.

B. From a lot of not less than 10 precast concrete ties, produced in accordance with these Specifications, 4 precast ties shall be selected at random for laboratory testing.

C. The 4 precast concrete ties shall be measured and examined to determine compliance with the design requirements. Upon satisfactory completion of this examination, the precast concrete ties shall be identified as Tie No. 1 through Tie No. 4. Ties No. 1 and No.2 shall be subjected to the stipulated performance tests. Ties No. 3 and No. 4 shall be retained by UTA for further test use and as a control for surface appearance check on ties subsequently manufactured.

3.2 DESIGN QUALIFICATION TESTS FOR STANDARD AND SPECIAL CONCRETE TIES

A. Design qualification tests shall be in accordance with the current edition of AREMA Manual for Railway Engineering, Chapter 30, Section 4.9, Testing of Monoblock Ties.

1. Rail Seat Positive and Negative Vertical Load Test:

    a. With the precast concrete tie supported and loaded, a load increasing at a rate of not greater than 5,000 pounds per minute shall be applied until a load of 20,000 pounds is obtained for the positive and 12,000 pounds is obtained for the negative. This load shall be held for not less than 3 minutes during which time an inspection shall be made to determine if any cracks greater than one inch long occur in the vertical length. An illuminated 5x power magnifying glass shall be used to locate cracks. If structural cracking does not occur, the requirements of this test have been met.

    b. If the precast concrete tie fails to meet the requirements stated above, two additional precast concrete ties from the same lot shall be tested and accepted only if both of the retested precast concrete ties meet the acceptance criteria.

    c. Following the rail seat vertical load test, a rail seat repeated-load test shall be performed in accordance with Section 4.9.1.5 of the current edition of AREMA Manual for Railway Engineering.

2. Center Negative Bending Moment Test:

    a. With the concrete tie supported and loaded, a load increasing at a rate of not greater than 5 kips per minute shall be applied until a load of 8,000 pounds is achieved. This load shall be held for not less than 3 minutes, during which time an inspection shall be made to determine if any structural cracking occurs. An illuminated 5x power magnifying glass shall be used to locate cracks. If structural cracking does not occur, the requirements of this test have been met.

3. Center Positive Bending Moment Test:

    a. With the concrete tie supported and loaded, a load increasing at a rate of not greater than 5 kips per minute shall be applied until a load of 5,000 pounds is achieved. This load shall be held for not less than 3 minutes, during which time an inspection shall be made to determine if any structural cracking occurs. An illuminated 5x power magnifying glass shall be used to locate cracks. If structural cracking does not occur, the requirements of this test have been met.

4. Bond Development, Tendon Anchorage, and Ultimate Load Test:

    a. Test shall be in accordance with Section 4.9.1.8 of the current edition of AREMA Manual for Railway Engineering.

5. Fastening Insert Test:

a. During the pull-out test, an axial load of 12,000 pounds shall be applied to one shoulder and shall be held for not less than 3 minutes, during which time an inspection shall be made to determine if there is any slippage of the shoulder or any cracking of the concrete. Mortar cracking in the vicinity of the shoulder is not a cause for failure. If failure of the insert occurs, the entire test has failed.

b. Following successful completion of the insert pull-out test, the torque test shall be performed on each insert. A torque of 339 Nm shall be applied about the vertical axis of the insert by means of a calibrated torque wrench and a suitable attachment to the insert. The torque shall be held for not less than 3 minutes. Ability of the insert to resist this torque without rotation, cracking of the concrete or permanent deformation shall constitute passage of this test.

3.3 PRODUCTION QUALITY CONTROL TESTS FOR THE STANDARD AND SPECIAL CONCRETE TIES

A. During production, quality control tests shall be performed to insure a uniform, high quality product. Daily quality control tests shall be performed on one precast concrete tie selected at random from every 200 precast concrete ties produced each day, or fraction thereof.

B. The distance from the center of the track to the center of the rail seats shall be verified by use of a template. The rail seat configuration and location of all shoulders shall be verified and recorded.

C. The following tests shall be performed as part of the daily production testing and shall be in accordance with Section 4.9.2 of the current edition of AREMA Manual for Railway Engineering.

1. Rail Seat Vertical Positive Load Test: The load shall be applied at a rate of at least 5 kips per minute and be held for at least 1 minute.

2. Fastening Insert Test: The test shall be performed on all inserts per tie when the instant demolding process is used.

3.4 INSPECTION OF MATERIALS FOR THE STANDARD AND SPECIAL CONCRETE TIES

A. All material furnished in this Contract shall be presented for inspection at the place of manufacture.

B. The CONTRACTOR shall afford the ENGINEER access and, without charge, all necessary facilities to examine the work, at any time during this progress, as well as the finished product, to satisfy the ENGINEER that the materials comply with these specifications. Regular examination of the product will take place during normal working hours.

C. Material for inspection shall be presented in a safe area away from excessive noise and manufacturing activities. Excessive noise shall be considered any sound or sounds in excess of 70 Db.

D. The CONTRACTOR shall send the ENGINEER written notice for inspection at least 30 working days in advance of availability for inspection.

E. UTA and the CONTRACTOR shall arrange inspection of procured concrete ties for acceptance by UTA. UTA shall identify in writing any defects of the materials supplied by the CONTRACTOR.

3.5 HANDLING, DELIVERY, AND STORAGE

A. Precast concrete ties shall be handled only by means of acceptable handling devices. The ties shall not be handled before they are stressed to sustain all forces and bending moments which are caused by the handling operations.

B. Precast concrete ties shall be delivered in flat deck vehicles and shall be braced during transportation to prevent any movement that could cause damage along with eccentric loading from the stacking of the ties. The ties shall be delivered in a horizontal position and shall be braced with wooden spacer blocks in such a manner that the top surface of cast-in-place shoulders do not contact with any other ties. The ties shall be loaded no more than 6 layers deep.

END OF SECTION

SECTION 34 11 38

LRT – RAIL CLIPS AND CAST SHOULDERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. This Section defines the requirements for the design, manufacture, supply, inspection, testing and delivery of elastic rail fasteners and cast-iron shoulders for use on standard and special concrete ties on ballasted track.

B. Measurement and Payment:

1. No separate measurement and payment will be made for the work described in this section.

1.2 RELATED SECTIONS

34 11 35 – Concrete Ties

34 11 93 – Other Track Materials

1.3 REFERENCES

Sponsor	Number	Subject
ASTM	E709-01	Standard Guide for Magnetic Particle Examination
BSI	BS EN 1562:1997	Malleable Cast Irons
BSI	BS EN 1536:1997	Spheroidal Graphite Cast Iron
BSI	BS EN 10089:2002	Hot Rolled Steels for Quenched and Tempered Springs

1.4 SUBMITTALS

A. Submit the following:

1. Detail drawings for rail clips and cast shoulders. The drawings shall show that the shoulder will accommodate either Pandrol FASTCLIP, or an equivalent rail clip design. See Section 34 11 35 “Concrete Ties.”

2. Inspection and Test Plan and Procedures.

3. Packaging Procedures.

4. Clip hardness and toe load test procedures, including acceptance criteria.

1.5 QUALITY ASSURANCE/QUALITY CONTROL

A. Quality assurance/quality control shall be in accordance with the requirements of the General Provisions, except as modified herein.

B. Rail Clips:

1. Mill Test certificates for raw materials supplied to the manufacturer shall be available for review by the UTA at anytime during production.

2. Clip hardness and Toe Load tests shall be performed and reports shall be available for review by the UTA at any time during production.

3. Visual, dimensional and magnetic particle inspections shall be performed and reports shall be made available for review by the UTA at anytime during production.

4. Wet fluorescent magnetic particle testing in accordance with ASTM E709 shall be performed on 10% of the first 200 rail clips manufactured. The 10% sample shall be selected by the CONTRACTOR's QA representative, and the testing shall be performed in the presence of the CONTRACTOR's QA representative. The tested rail clips shall show no signs of cracks in any part of the rail clips. Should any of the test clips be defective, all 200 of the clips shall be rejected and revise the production procedure accordingly. Ten percent of the first 200 of the revised production lot shall be tested as above. One hundred percent acceptance of this sample lot shall qualify the clips for production.

C. Cast Shoulders:

1. Material Conformance Inspection Certificates detailing the chemical analysis and mechanical properties shall be available for review by the UTA at any time during production.

2. Hardness tests, gauging and visual inspections shall be performed and reports shall be available for review by the UTA at anytime during production.

3. Prior to start of production, deliver two Test Bars representative of the cast shoulders to the Project Director.

4. Prior to start of production, submit to the UTA a historical fatigue test report, if available, or perform a fatigue test conforming to the following boundary conditions:

a. The test specimen shall consist of the proposed cast shoulder embedded into a block of concrete representing a precast tie, a rail pad meeting the requirements of Section 34 11 93 "Other Track Materials" of these specifications, and a section of the designated rail section attached to the cast shoulder by means of a rail fastening clip meeting the requirements of this section.

b. The block of concrete shall have a specified 28 day compressive strength of not greater than 5,000 psi and the average prestress shall not exceed 700 psi.

c. The rail shall be installed at a cant of 1:40.

5. A cyclic loading shall be applied at the head of the rail section for two million cycles. One cycle shall consist of applying the load from zero to the maximum load and then back to zero. The maximum load shall consist of a vertical component of 5,000 pounds per shoulder and a lateral component of 1,500 pounds per shoulder applied at the same time from the gauge side. The frequency shall be regulated to prevent the temperature of the components from exceeding 1600 F.

6. The test assembly shall withstand 2 million cycles of load application with no evidence of failure. The test assembly shall be disassembled and, upon visual inspection, no component of the assembly shall exhibit any evidence of failure by slippage, yielding, abrasion, or fracture at any time during the test. The rail shall exhibit no evidence of wear or grooving that would contribute to a failure of the rail. The concrete test block at the anchorage point shall exhibit no evidence of failure as a result of the dynamic test.

PART 2 – PRODUCTS

2.1 RAIL CLIPS

A. Rail fastening clips shall be manufactured from alloyed spring steel in accordance with BS EN 10089, Grade 251A58, or equivalent.

B. Formed rail fastening clips shall be heat treated to achieve a hardness of 44 to 48 Rockwell C.

C. Rail fastening clips shall be free of burrs or flanges which might be considered harmful when handled, or which might affect the efficient installation of the clip.

2.2 CAST SHOULDERS

A. Cast shoulders shall be cast from pearlitic malleable iron, grade P55-04 (BSI BS EN 1562), or Spheroidal graphitic iron/nodular graphitic iron, grade 500/7 (BSI BS EN 1563).

B. Cast shoulders shall be identified by the manufacturer’s identification mark, pattern number and last two digits of the year of manufacture, plus a date code which identifies the day and month of manufacture. The drawing number also shall appear on each casting.

C. Completed cast shoulders shall be cleaned, de-burred and inspected as detailed in the CONTRACTOR’s Product Specification.

D. No coating is required for the completed cast shoulders.

PART 3 – EXECUTION NOT USED

END OF SECTION

SECTION 34 11 45

LRT – TRACKWORK – FIELD RAIL WELDING

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. This Section specifies the following:

a. This Section specifies the furnishing, installation and testing of field rail welds to connect CWR strings as shown on the Contract Drawings and as specified herein.

b. The CONTRACTOR shall, wherever possible, utilize a mobile electric-flash butt welding plant in lieu of thermite field welds.

c. Qualification testing, production testing, and inspection.

B. Measurement and Payment:

1. No separate measurement and payment will be made for the work described in this section.

1.2 RELATED SECTIONS

34 11 47 – Trackwork – Rail Handling, Plant Welding and Storage

1.3 REFERENCES

Sponsor	Number	Subject
AREMA	Vol. 1, Ch 4	2008 Manual for Railway Engineering, Part 3, Section 3.10 to 3.14
ASTM	E 10-07a	Standard Test Method for Brinell Hardness of Metallic Materials
ASTM	E 94-04	Standard Guide for Radiographic Examination
ASTM	E 164-03	Standard Practice for Ultrasonic Contact Examination of Weldment
ASTM	E 709-01	Standard Guide for Magnetic Particle Examination
ASNT	CP-189-2006	Standard for Qualification and Certification of Nondestructive Testing Personnel
AWS	D 1.1	Structural Welding Code

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein. Submittals shall include:

1. Field welding procedure Specification.

B. Procedure qualification test results.

C. Thermite weld performance qualification records.

D. A daily report of field welding records.

E. Certified material test reports for the thermite powder portions.

F. Welding supervision qualifications, certifications and experience of record.

G. Identification of the testing service, their testing program and procedures, and a copy of their agreement.

PART 2 – PRODUCTS

2.1 MATERIALS

A. For welds that cannot be performed with an on-site electric flash-butt rail welding plant, the CONTRACTOR shall select and furnish a welding kit that conforms to the requirements of AREMA Chapter 4, Part 3, Section 3.14 Specification for the Quality Assurance of Thermite Welding of Rail, except as modified herein. The thermite welding kit material manufacturer shall certify the thermite powder portions are in compliance with the referenced requirements. Use only welding products which have passed the manufacturer’s quality programs.

B. Thermite Welding Kit: Thermite welding kit can be selected from the following brands of rail welding kits or from an approved equal.

1. Thermit Self PreHeat - as manufactured by Orgo-Thermit Inc., Manchester, New Jersey.

2. Railtech Boutet - as distributed by Railtech Boutet, Napoleon, Ohio.

3. Railwel Calorite Welding Procedure – Morrison Metalweld Process Corp., Canfield, Ohio, 44406.

C. The rail welding kits used when welding head hardened rail shall conform to the process manufacturer's recommended standard for such work.

D. On-site electric-flash butt rail welding materials shall be in accordance with the requirements of Section 34 11 47 “Trackwork – Rail Handling, Plant Welding, and Storage.”

PART 3 – EXECUTION

3.1 WELDING PROCEDURES

A. Thermite Welding Process:

1. All welding procedures and methods shall conform to the requirements of AREMA "Thermite Welding - Rail Joints", except as modified herein.

B. Electric Flash-Butt Welding Process:

1. On-site electric flash-butt welding of Continuous Welded Rail (CWR) fabrication shall be in accordance with the AREMA 2008 Specification Chapter 4, Part 3, Section 3.10 “General Specification for in-track Rail Welding using Electric Flash Butt (EFB) Welding Equipment”, Section 3.12 “Specification for Fabrication of Continuous Welded Rail."

2. On-site electric-butt welding process and equipments shall meet the applicable requirements of Section 34 11 47 “Trackwork – Rail Handling, Plant Welding, and Storage.”

3.2 PROCEDURE SPECIFICATION

A. The CONTRACTOR shall prepare a detailed procedure Specification for the ENGINEER’s review and approval covering step-by-step procedures to be employed in making field thermite welds. A complete description of each of the following items and any other essential characteristics shall be included in the procedure Specification:

1. Manufacturer's trade name for welding process.

2. Method used for cutting and cleaning of rail ends. Flame cutting of rail ends will not be allowed.

3. Minimum and maximum gap between rail ends.

4. Method and equipment used for maintaining rail gap and alignment during welding.

5. Method used for preheating rail ends including time and temperature.

6. Tapping procedure including minimum time required to cool weld under the mold insulation.

7. Method used for removing gates and risers and finishing weld suitable for ultrasonic inspection, including a description of special tools and equipment.

8. The manufacturer's recommended procedure for welding premium rail if different from requirements for standard rail.

9. Quality control procedures.

3.3 QUALIFICATION OF FIELD WELDING PROCEDURE

A. Thermite Welding Process:

1. The CONTRACTOR shall qualify the procedure Specification described above and as specified in AREMA Manual of Railway engineering,2008, Chapter 4, Part 3, Section 3.14 “Specification for the Quality Assurance of Thermite Welding of Rail” and by preparing and testing six qualification test welds prior to beginning production welding. The qualification test welds shall be prepared by the contracting welding crews in conformance with the procedures listed above on short lengths of rail.

    a. Two qualification weld samples joining standard rail to standard 115RE rail

    b. Two qualification weld samples joining high strength rail to high strength 115RE rail

    c. Two qualification weld samples joining standard rail to high strength 115RE rail

2. The qualification test welds shall be inspected and tested by the testing service in accordance with the following requirements:

    a. Paragraph 3.4, Weld Quality

    b. Paragraph 3.13, Weld Inspection and Testing

    c. Paragraph 3.14, Visual and dimensional weld inspection

    d. Paragraph 3.15, Ultrasonic Weld Testing

    e. Paragraph 3.16, Magnetic Particle Testing

3. The qualification test weld shall be sectioned longitudinally through the middle of the rail and chemically etched. The etch shall show a clean definition of the weld metal and heat affected zone of the weld joint. The testing service shall examine the etched sections for conformance with the weld quality requirements of Paragraph 3.4, below. One of the etched sections and the report of the testing service shall be submitted to the ENGINEER.

4. The procedure Specification will be considered qualified if the weld kit and all tests and inspections meet or exceed the acceptance requirements. If any test or inspection is failed, the CONTRACTOR shall submit and qualify a revised procedure Specification in accordance with the requirements herein.

5. Production field welding shall not begin until a procedure Specification is qualified in accordance with the requirements herein.

3.4 ELECTRIC FLASH-BUTT WELDING PROCESS

A. Quality Assurance for the electric flash-butt welding process shall be in accordance to AREMA Manual of Railway Engineering, 2008, Chapter 4, Part 3, Section 3.11 “Specification for the Quality Assurance of Electric Flash-Butt Welding of Rail.”

3.5 WELD QUALITY

A. Each weld shall have full penetration and complete fusion, and be free of cracks.

B. Small porosity and slag inclusion which show on radiographic film will be accepted if the total area of internal defects does not exceed 0.09 square inches and the largest single defect does not exceed 0.180 inch in diameter.

3.6 WELDING SUPERVISION

A. Thermite Welding:

1. All welding shall be performed under the direct supervision of a welding foreman or supervisor with a minimum of five years documented experience supervising field welding. In addition, a manufacturer's representative experienced in thermite field welding shall be present at the job site on an as-needed basis and shall witness the making of thermite welds for acceptance.

B. Flash-Butt Welding:

1. All welding shall be performed by an experienced crew which has completed at least two other projects using the flash-butt welding process. The weld foreman or supervisor shall have a minimum of five years experience with the flash-butt welding process on similar projects and shall be familiar with the process execution in accordance with AREMA Manual of Railway Engineering, Chapter 4, Part 3, Section 3.10 “General Specification for In-Track Rail Welding Using Electric Flash-Butt (EFB) Welding Equipment.”

3.7 WELDING REQUIREMENTS

A. Thermite Welding:

1. Rail End Preparation: The rails to be welded shall be cleaned of all grease, oil, dirt, loose scale and moisture to a minimum of six inches back from the rail ends, including all the rail surface, by use of a wire brush, to completely remove all dirt and loose oxide, and by use of oxy-acetylene torch under a minimum temperature of 250-degrees F to remove any grease, oil or moisture. The face of the rail ends shall be aligned and arranged at right angles and cut by using a power actuated saw, or abrasive rail cutting machine, and further cleaned to remove all scale and rust by use of a power actuated grinder with abrasive wheel for two inches on each side of the weld. Rail ends shall show no steel defects, dents, or porosity before welding. All burrs and lipped metal which would interfere with the fit of the mold shall be removed.

2. Weld Gap: The minimum and maximum gap shall be in accordance with the Specifications for the type of thermite weld being made, and as provided by the manufacturer of the weld kit. The minimum measurement shall be made with a go or no-go gauge made of the specified dimensions for the thermite process used. The gap must be adjusted if under the minimum or more than ⅛ inch over the specified gap.

3. Sealing the Molds: No mold sealant or luting material shall be introduced into the weld chamber.

4. Preheating: The rail ends shall be preheated, prior to welding, to a sufficient temperature and for sufficient time, as indicated in the approved procedure Specification, to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld. The rail temperature shall be checked by the use of tempsticks, or as directed by the ENGINEER.

5. Post heating: The molds for thermite field welds shall be left in place after tapping for sufficient time to permit complete solidification of the molten metal and proper slow cooling to prevent cracking and provide a complete weld with proper hardness and ductility.

6. Weather: Welding shall not be done during periods of precipitation, winds of 25 mph or more, or in the presence of atmospheric electrical activity except by permission of the ENGINEER and with sufficient protection to ensure adequate protection of the weld materials.

7. Other Work: During the setting up and actual welding, other work which would in any way move, vibrate, or otherwise interfere with the welding outcome will be prohibited. Necessary precautions shall be taken to prevent disturbing the weld immediately after the pour when working adjacent to a grade crossing.

8. Storage of Thermite Welding Materials: Handle and store welding products in accordance with the manufacturer's recommendations. Crucibles, molds and thermite mix portions shall be stored in a dry location in order to prevent moisture contamination. Thermite mix portions stored beyond their shelf life shall not be used.

9. Only standard preheat will be allowed. Weld kits must be new.

B. Electric Flash-Butt Welding:

1. Electric flash-butt welding requirements shall be in accordance with the AREMA Manual of Railway Engineering, Chapter 4, Part 3 Section 3.10 "General Specification for In-Track Rail Welding Using Electric Flash-Butt (EFB) Welding Equipment."

3.8 THERMITE WELD LOCATIONS

A. The CONTRACTOR shall locate field welds in accordance with the following:

1. Field welds in opposite rails shall be staggered a minimum of 10 feet for connecting CWR strings and a minimum of 2 feet at all other locations, except as otherwise accepted by the ENGINEER.

2. Except for welded rail joints in shop curved rail; field welds shall not be located within street intersections and grade crossings or within 10 feet of the edge of the traveled portion or sidewalk area.

3. Field welds shall not be located within 15 feet of a bolted rail joint.

4. Do not position field welds either on or within six inches of the edge of a rail seat.

5. Field welds shall not be positioned within six inches from the edge of a switch tie plate.

6. Field welds shall not be located within 13' of another field weld on the same rail or within 5 feet of a shop weld on the same rail, unless approved by the ENGINEER.

3.9 ALIGNMENT

A. The ends of the rails to be welded shall be properly gapped and aligned to produce a weld which will conform to the following alignment tolerances. The rail gap and alignment shall be held by a hydraulic rail puller/expander and alignment jig without change during the complete field welding cycle.

B. Alignment of rail shall be done on the head of the rail.

1. Vertical alignment shall provide for a flat running surface. Any difference of height of the rails shall be in the base.

2. Horizontal alignment shall be done in such a manner that any differences in the width of heads of rail shall occur on the field side.

C. Horizontal offsets shall not exceed 0.040 inch in the head and 0.125 inch in the base.

D. Surface Misalignment Tolerance.

1. Combined vertical offset and crown camber shall not exceed 0.040 inch per foot at 60-degrees F.

2. Combined vertical offset and dip camber shall not exceed 0.010 inch per foot at 60-degrees F.

E. Gauge Misalignment Tolerance: Combined horizontal offset and horizontal kink shall not exceed 0.040 inch per foot at 60-degrees F.

3.10 FINISHING

A. The weld shall be finished with a rail mounted rail head grinder specifically designed for the work. Finishing shall conform to the following tolerances:

1. Top of rail head, plus 0.010 inch to minus 0 inch of the parent rail section.

2. Sides of rail head, plus or minus 0.010 inch of parent rail section.

3. The balance of the rail section shall be finished with a hand-held grinder as required to remove notches, protrusions, gouges, visible cracks and other defects as follows:

a. For ballasted track: within 0.125 inch of the parent rail steel

b. For embedded track: within 0.062 inch of the parent rail steel

4. All grinding shall blend to the parent rail section and shall not overheat the steel. Heavy grinding shall be completed while the steel is still hot from welding.

3.11 WELD NUMBERING

A. Mark a sequential weld number on the rail immediately adjacent to the weld using a quality lead paint marker at the time the weld is made. Paint the number two inches from the finished weld on the web of the rail.

B. Number welds sequentially in the order in which they are made.

C. The ENGINEER will provide the CONTRACTOR with the initial weld number.

D. When defective welds are replaced, assign a new sequential number to the new weld by adding a letter to the defective weld number.

E. The weld number and letter if applicable must correspond with the number recorded in the field welding reports.

3.12 FIELD WELDING RECORD

A. Field welding records shall be maintained by the CONTRACTOR and submitted to the ENGINEER on a daily basis during the production of field welds. These records shall include:

1. Date and time welded
2. Weld number
3. Location by station stating track and rail
4. Type of joint - Standard to Standard, Premium to Premium, Standard to Premium
5. CONTRACTOR’s welding personnel
6. ENGINEER’s representative
7. Manufacturer's representative
8. Rail gap (nearest 1/16 inch)
9. Weather, air and rail temperature
10. Weld kit trade name
11. Track alignment (curve, tangent, etc.), anchorage and rail stress
12. Inspection date
13. Inspector's name
14. Inspection results
15. Testing date

16. Evaluator's name

17. Test results

3.13 QUALIFICATION OF WELDING CREW

A. Prior to production welding, each crew, including foreman or supervisor of that crew, shall prepare a qualification weld in 115RE rail, out of track, at the expense of the CONTRACTOR. The weld shall be prepared in accordance with the approved procedure Specification and will be witnessed by the ENGINEER.

1. Testing: Testing agency shall visually inspect the crew qualification welds and perform ultrasonic testing and Brinell hardness testing on each.

2. Acceptable Criteria: Weld quality requirements of Paragraphs 3.4 and 3.6.

3. Test Record: The test record shall contain the names of the crew members, including foreman or supervisor of that crew, who performed the qualification weld and briefly describe their specific duties. The test records shall also show results of visual inspection, ultrasonic testing and rail hardness test. All performance qualification records shall be submitted to the ENGINEER at least 14 calendar days prior to production welding. Production welding shall not commence until qualification test welding records have received written approval by the ENGINEER.

4. Requalification: The ENGINEER reserves the right to require the re-qualifications, at the CONTRACTOR’s expense, of any crew of welders whose work fails to meet the specified requirements.

3.14 WELD INSPECTION AND TESTING

A. All field weld inspection and testing shall be carried out by an independent testing service, selected by and at the expense of, the CONTRACTOR. The testing service and their testing program and procedures shall be subject to the approval of the ENGINEER.

B. The CONTRACTOR shall submit a copy of his agreement with the testing service to the ENGINEER for approval. The agreement shall specify that the testing agency is directly responsible to the ENGINEER, that all subsequent communication between the testing services and the CONTRACTOR regarding the work under this Contract shall only be through the ENGINEER, and that the agreement shall run for the duration of the Contract and can only be terminated by the ENGINEER.

C. Testing service personnel performing non-destructive examination (NDE) shall be certified as Level II or III for NDE methods in accordance with ASNT CP-189; and must have at least one year of experience testing for defect in rail.

D. The testing service shall certify whether or not each weld meets the quality criteria immediately following its inspection, and shall indicate acceptance or rejection by marking the tested weld. Written reports shall be submitted to the ENGINEER within five working days of testing a weld. The ENGINEER will forward copies to the CONTRACTOR.

E. Unless otherwise allowed for by the ENGINEER, inspection and testing results of field rail welds shall be no further than 10 welds behind the production of welds.

F. Weld inspection and testing shall be in accordance with AREMA Manual of Railway Engineering, Chapter 4. Part 3, Section 3.12 “Specifications for Prefabrication of Continuous Welded Rail” and Section 3.14 “Specification for the Quality Assurance of Thermite Welding Rail.”

3.15 VISUAL AND DIMENSIONAL WELD INSPECTION

A. Each weld shall be visually inspected to check for surface defects such as cracks and to determine conformance with the alignment and finishing tolerances herein.

1. Acceptance Criteria:

a. Weld Quality, Paragraph 3.4

b. Alignment, Paragraph 3.8

c. Finishing, Paragraph 3.9

2. Inspection Procedures: The testing service shall prepare an inspection program for approval by the ENGINEER. The program shall include a description of proposed procedures, equipment and reports.

3.16 ULTRASONIC WELD TESTING

A. All field welds testing shall be ultrasonically tested (UT) over the entire cross section of the head, web and base. The UT equipment shall meet the requirements of AWS D1.1, Paragraph 6.17. The procedure shall meet the requirements of ASTM E 164. Prior to performing production UT of welds, all UT technicians shall demonstrate to the satisfaction of the ENGINEER that they can discern and identify indication produced by slag, porosity, lack of fusion, and cracks.

B. Testing Procedures: The testing service shall prepare a testing program for approval by the ENGINEER. The program shall include a description of the proposed procedures, materials, equipment, safety requirements and report.

C. Acceptance criteria shall be as follows:

1. Welds showing a response at any level that is identified as a crack or lack of fusion shall not be acceptable.

2. Welds showing a response that is less than 50% of the primary reference level shall be acceptable.

3. Welds showing a response greater than 50% but that do not exceed the primary reference level are acceptable, providing that all of the following apply:

a. The defects are evaluated as slag or porosity.

b. The largest defect does not exceed 0.180 inch in its largest dimension.

c. The total area of the defects does not exceed 0.09 square inch.

d. The sum of the greatest dimension of defects in a line does not exceed ⅜ inch.

4. Welds showing a response that exceeds the primary reference level shall not be acceptable.

D. Test Report: Each weld examined shall be recorded on a report form which includes as a minimum the following information:

1. Technique Sketch

2. Type of Equipment, Size of Transducer, Frequency, Angle

3. Calibration Data

4. Defect Description: Depth, Location, Size, Character

5. Equipment Identification: Serial Numbers

6. Name of Operator

7. Date of Inspection

3.17 MAGNETIC PARTICLE TESTING

A. All field welds shall be magnetic particle tested (MT). The magnetizing equipment shall be an electro-magnetic yoke meeting the following requirements:

1. DC lift capacity of 40 lbs. and/or

2. AC lift capacity of 10 lbs. at the maximum pole spacing.

a. The procedure shall meet the requirements of ASTM E 709.

b. All weld surfaces shall be tested except the underside of the rail base.

B. Testing Procedures: The testing service shall prepare a testing program for approval by the ENGINEER. The program shall include a description of the proposed procedures, materials, equipment, safety requirements and report.

C. Acceptance Criteria: The weld quality shall meet the requirements of Paragraph 3.4, above.

3.18 REWELDING

A. Welds rejected during inspection and/or testing shall be cut out and rewelded if possible, or replaced with at least a 19' rail welded in its place in accordance with this Specification.

B. Minor defects may be repaired by qualified welders in accordance with repair procedures approved by the ENGINEER.

3.19 CLEANUP

A. Upon completion of each weld, the CONTRACTOR shall clean the LRT right-of-way of all welding debris, including discarded molds, slag, discarded equipment and any other debris that accumulated during the work.

END OF SECTION

SECTION 34 11 47

LRT – TRACKWORK – RAIL HANDLING, PLANT WELDING AND STORAGE

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. This Section specifies the furnishing of a mobile electric-flash butt welding plant; the handling of rail to or from stockpile to plant or track structure; mobile plant welding of rails into continuous strings, qualification testing, production testing, rail inspection, and handling and stockpiling of rail at designated locations.

2. Upon completion of mobile plant welding operations, the CONTRACTOR shall remove from the job site all plant welding facilities and surplus or discarded Materials, and rehabilitate the job site to conditions approved by the ENGINEER.

3. The CONTRACTOR shall assume full responsibility for the storage, security and issuance from stockpile of individual rail lengths during the period of the Contract. At the time of completion of the Contract, this responsibility will be assumed by others.

B. Measurement and Payment:

1. No separate measurement and payment will be made for the work described in this section.

1.2 RELATED SECTIONS

34 11 34 – Standard and High Strength Rail

34 11 45 – Trackwork – Field Rail Welding

1.1 REFERENCES

Sponsor	Number	Subject
AREMA		Manual for Railway Engineering, Vol. 1, Chapter 4, Part 2 & 3 – “Specification for Fabrication of Continuous Welded Rail”, “Specifications for Steel Rails” and “Specifications for the Quality Assurance of Electric Flash-Butt Welding of Rail.”
AREMA		Chapter 5, Part 5, Section 5.2.3, “Handling and Transporting Continuous Welded Rail.”
ASTM	E 10-07a	Standard Test Method for Brinell Hardness of Metallic Materials
ASTM	E 94-04	Standard Guide for Radiographic Examination

1.2 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein. Submittals shall include:

1. Work program and schedules for rail welding.

2. Brush recorder charts for each electric-flash butt weld.

3. Daily reports of production rail welding inspection and testing.

4. Welding procedure qualification.

5. A written description of welding ability, including facilities, personnel qualifications and a list of similar completed projects.

6. Working and laying out drawings, manufacturer's catalog, performance data and detailed Specifications of the equipment to be used for rail welding and handling.

7. Choice of testing laboratory, its program and procedures, and the testing laboratory agreement.

8. Rail Schedule: The following requirements and restrictions shall apply:

   a. Prepare and submit a detailed Rail Schedule in graphical form that illustrates the length and composition of each rail string to be fabricated. Scale ratio of the drawing shall be not less than 1:40. The location of each and every rail in finished track in each individual welded rail string shall be determined and illustrated to within a tolerance of six inches. Each string shall be designated by track designation, engineering stations at each end of the rail string, and right rail or left rail as determined by facing up the direction of increasing engineering station.

   b. The schedule shall indicate which strings or which portions of strings will be head-hardened rail.

   c. If any strings are to be cut in the field, the schedule shall indicate the locations of the proposed cuts. Indicate the location of connections to rails previously installed by either this Contract or by others. Indicate the sequence of rail string installation; for example: whether the rails through a street crossing will be installed before or after the installation of rails in an adjoining section of exclusive right-of-way. Indicate whether individual welds will be a thermite weld or an electric flash-butt weld.

   d. The rail schedule shall be designed to optimize the use of short rails, shall minimize the generation of unusable short sections of rails, and minimize the number of thermite welds. Illustrate that welds in opposite rails will not occur at prohibited locations. Minimum rail length used in welded strings shall not be less than 19 feet.

   e. The CONTRACTOR will not be permitted to install any rail prior to the UTA’s acceptance of the Rail Schedule.

9. Location(s) where the welding plant will be set up.

10. Methods for handling the CWR from welding plant storage to the location of installation.

PART 2 – PRODUCTS

2.1 MATERIALS

A. For furnishing Standard and High Strength Rail see Section 34 11 34 “Standard and High Strength Rail.”

B. CONTRACTOR to pre-curve head hardened 115RE rail in 39' long sections for use in curves with radii equal or less than 300 feet. CONTRACTOR will supply head hardened rail in accordance with Section 34 11 34 “Standard and High Strength Rail” in 80 ft. length and CONTRACTOR shall cut rail to required length for supplying pre-curved rail as detailed on the contract drawings.

PART 3 – EXECUTION

3.1 RAIL STORAGE AND HANDLING

A. Layout Drawings: The CONTRACTOR shall submit layout drawings, lists and details of equipment for the storage and handling of rails.

B. Handling and Storage:

1. Equipment and methods to handle and store rail shall conform to the requirements of AREMA: Chapter 5, Section 5.2.3, Handling and Transporting Continuous Welded Rail.

2. Operations likely to cause scratching, notching, rubbing, scoring, or striking of the rails during any handling operations shall not be used.

3. Individual rails shall be supported off the ground at spacings such that the load on the supporting ground will not exceed 2,500 pounds per square foot.

4. Storage areas for 115RE rails, precurved rails and continuous welded into CWR strings will be identified by the CONTRACTOR.

5. At the completion of the Contract, the CONTRACTOR shall return any storage facilities used in a condition of maintenance and operation satisfactory to the ENGINEER.

C. The rail welding plant or plants shall meet requirements for handling and welding of rail as specified.

3.2 RAIL WELDING

A. The CONTRACTOR shall submit a written description of welding ability, including facilities, personnel and list of similar, completed projects.

B. Rail welding shall be done by the electric-flash butt welding process. Thermite welds shall be used only at locations where it is impractical to perform Pressure Welds, such as for welding shop curved rails which cannot be clamped into a pressure welding machine. In such situations, the CONTRACTOR is permitted to use thermite field welding kits in accordance with Section 34 11 45 “Trackwork – Rail Handling, Plant Welding and Storage.” Electric flash-butt welding shall conform to AREMA Chapter 4 - Part 3 - Specifications Section 3.12. Specification for Fabrication of Continuous Welded Rail except as modified herein. All production welding shall use procedures stated below.

C. Each welding machine for use with a mobile plant shall be equipped with a brush recorder to produce charts showing traces of electrical impulses and movable platen travel. A chart shall be submitted to the ENGINEER for each weld. If the chart indicates performance which is not in conformance with the approved standards, the weld shall be rejected.

D. The CONTRACTOR shall furnish all electric power and utilities required for the Work.

E. Provide nominal string lengths for CWR suitable to the local conditions and schedule.

F. Paint string number and length on both sides of the rail web at each end of each string to identify the string.

G. End of rails shall be furnished undrilled.

H. Rails shall be welded so that heat numbers appear on the same side in each string.

I. Rail Straightening and Cutting Back:

1. Rail ends not meeting the requirements of the AREMA: Specification for Fabrication of Continuously Welded Rail shall be straightened or cut back.

2. When, in the judgment of the CONTRACTOR, rail ends cannot be straightened or cut back to achieve the required rail end tolerance, the rail will be rejected for fabrication into welded rail.

3. Rejected rail shall be marked and stockpiled in an on-site area designated by the ENGINEER.

J. Cutting of Rail:

1. All rails cut, prior to welding, shall be cut clean and square by means of rail saws or abrasive cutting disks in accordance with AREMA: Specifications for Steel Rails.

2. Flame cutting of the rail using plasma cutters and all ordinary types of cutting torches will not be allowed.

K. Rail End Preparation:

1. Clean the rails free of grease, oil, dirt, scale and moisture to a minimum of 6" back from the rail ends, including the rail end surfaces.

2. Align the faces of the rail ends. Divide any difference in the width of the rail heads equally on both sides of the head.

3. Vertical alignment shall provide for a flat running surface. Any difference of height of the rail shall be made in the base.

4. Rail ends to show no steel defects, dents or porosity before welding.

3.3 WELD QUALITY

A. Each weld shall have full penetration and complete fusion, and be free of cracks.

B. Small porosity and slag inclusion will be accepted if the total area of internal defects does not exceed 0.09 square inches and the largest single defect does not exceed 0.180" in diameter.

C. The Brinell hardness of the weld, measured on the head of the rail in the center of the weld in accordance with ASTM E10, shall be equal to the Brinell hardness of the parent metal with a tolerance of plus or minus 20 Brinell hardness numbers.

D. All welds shall conform to AREMA Chapter 4 - Part 3 - Specifications Section 3.11 Specification for the Quality Assurance of Electric Flash-butt Welding of Rail.

3.4 WELDING PROCEDURE QUALIFICATIONS

A. Test Welding:

1. Prior to beginning of production welding, a total of six test welds shall be made on each welding machine using the same welding procedure that will be used in production welding. Each test weld shall join two pieces of rail each a minimum of 30" in length. Three test welds for the standard rail and three test welds for the high strength rail shall be furnished and tested.

B. Production Welding:

1. Shop and field welds shall be tested by ultrasonic and magnetic particle inspection in accordance with a procedure satisfactorily reviewed by the ENGINEER. Shop welds shall include electric flash butt welds performed in the shop or at the site plant. Field welds shall be all welds performed after rail is laid to be welded in a CWR string generally done by a thermite welding process. These welds shall be in addition tested by radiographic inspection.

C. Testing Laboratory:

1. Inspection of welding procedures and testing of welds shall be performed by a reputable independent laboratory, selected and employed by the CONTRACTOR. The laboratory and their testing program and procedures shall be subject to the approval of the ENGINEER.

2. At least 30 days before initiating welding operations, submit a copy of the agreement with the testing laboratory for approval. The agreement will specify that:

a. The testing agency will be directly responsible to the ENGINEER.

b. That subsequent communication between the testing laboratory and the CONTRACTOR regarding the Work under this Contract will only be through the ENGINEER.

c. The agreement will run for the duration of this Contract.

D. Each test weld and field weld shall be radiographically tested with a minimum of five exposures: one transversely through the head, one transversely through the web, one transversely through the flange, and one vertically through each of the two flanges. All radiographic testing shall be performed in accordance with ASTM E 142. Radiographic film will be Type 1 or Type 2. Exposed film density shall be within the range of 1.5 to 3.8.

E. Each test weld, shop and field welds shall be magnetic particle tested by the coil method (longitudinal magnetization) using the dry powder method in accordance with ASTM E 709.

F. Each test weld, shop and field welds shall be ultrasonic tested in accordance with ASTM E 164.

G. Each test weld shall be tested for hardness in accordance with ASTM E 10. Longitudinally section the rail for a distance of 6" each side of the weld and test for Brinell Hardness. Test for hardness on the sectioned face at points on a grid pattern of 1/4" increments for 1" on each side of the centerline of the weld and on a grid pattern of 1/2" increments beyond the weld until the hardness is that of the parent metal.

H. Acceptance will be based on the weld quality requirements stated above.

I. If any of the test welds from a single machine are unacceptable, necessary alterations to the procedure shall be made by the CONTRACTOR, and five additional test welds produced and tested.

J. Production welding shall not begin on a machine until six acceptable test welds have been made on that machine.

K. Four additional test welds shall be required each time a welding machine is restored after a period of malfunctioning, after a welding crew or supervisor is replaced and after moving to a new site. Acceptance shall be in accordance with the provisions of this Section.

3.5 WELD NUMBERING

A. Mark a sequential weld number on the rail immediately adjacent to the weld using a quality lead paint marker at the time the weld is made. Paint the number two inches from the finished weld on the web of the rail.

B. Number welds sequentially in the order in which they are made.

C. The ENGINEER will provide the CONTRACTOR with the initial weld number.

D. When defective welds are replaced, assign a new sequential number to the new weld by adding a letter to the defective weld number.

E. The weld number and letter must correspond with the number recorded in the field welding reports.

3.6 FINISHING THE WELDS

A. The weld shall be finished with a rail mounted rail head grinder specifically designed for the Work. Finishing shall conform to the following tolerances:

1. Top of rail head, +0.010" to −0" of the parent rail section.

2. Sides of rail head, +0.010" to −0" of the parent rail section.

3. The balance of the rail section shall be finished with a hand-held grinder as required to remove notches, protrusions, gouges, visible cracks and other defects. All grinding shall blend to the parent rail section and shall not overheat the steel. Heavy grinding shall be completed while the steel is still hot from welding. Remaining weld shall not protrude more than +0.025" to −0" of parent rail section at base and sides.

3.7 INSPECTION AND TESTING OF PRODUCTION WELDING

A. The independent testing laboratory referred to in Paragraph 3.4.C. shall perform and report all inspection and testing of production welding. The ENGINEER, at his/her discretion, will observe all inspection and testing.

B. Each weld shall be visually and dimensionally inspected to determine conformance with the alignment and finishing tolerances in AREMA: Chapter 4, Specifications for Fabrication of Continuous Welded rail. Inspect each weld using a 3' straightedge along the centerline of the rail and 0.625" below top of rail on the gauge side of the rail head. Center the straightedge over the weld; the gap between the straightedge and the railhead must not exceed AREMA Chapter 4 criteria. Out-of-tolerance welds shall be cut out and re-welded by the CONTRACTOR in accordance with these Specifications and at the expense of the CONTRACTOR.

C. Production welding shall be tested and inspected as described in Paragraph 3.4 Welding Procedure Qualifications and specifically in Section 3.4 B, D, E and F.

D. The CONTRACTOR shall submit a Daily Welding Quality Control Report to the ENGINEER containing the following information:

1. Date and shift.

2. Inspector's and welding foreman's names.

3. Number of welds made, by sequential weld number.

4. Number of magnetic particle test rejections.

5. Number of dimensional tolerance rejections.

6. Number and type of other rejections.
7. Total number of rejections and re-welds.
8. Total number of welds accepted.
9. For each string produced:
    a. String number
    b. Lead Rail heat, ingot and letter
    c. End Rail heat, ingot and letter
    d. String length
    e. String temperature at the time of measurement of length

END OF SECTION

SECTION 34 11 93

LRT – OTHER TRACK MATERIALS

PART 1 – GENERAL

1.1 SUMMARY

A. Description:

1. This Section defines the requirements for the manufacture, testing, and supply of rail pads, miscellaneous hardware for fastening of running rail, rail lubricators, and bumping posts. All hardware shall be new and sized to match the fastener component for which they will be used.

B. Measurement and Payment:

1. No separate measurement and payment will be made for the work described in this section.

1.2 RELATED SECTIONS

A. Not Applicable

1.3 REFERENCES

A. Rail Pads:

1. High-density polyethylene rail pads shall be manufactured, tested, inspected, packaged and delivered in accordance with Pandrol Specification D-B Issue 2, or approved equivalent, and as modified herein.

B. Miscellaneous Hardware:

Sponsor	Number	Subject
ASTM	B633-07	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

1. Bolts and nuts shall conform to:

Sponsor	Number	Subject
AREMA	Chapter 4 Section 3.3	Rail Drillings, Bar Punching, and Track Bolts
AREMA	Chapter 4 Carbon-Section 3.5	Specifications for Heat-Treated Steel Track Bolts and Carbon-Steel Nuts

2. Spring washers shall conform to:

Sponsor	Number	Subject
AREMA	Chapter 4 Section 3.6	Specifications for Spring Washers

1.4 SUBMITTALS

A. Rail Pads

1. The Supplier's drawings of injection molded or extruded rail pads shall be submitted prior to production of pads. The submittal and review of these drawings shall not in any way relieve the CONTRACTOR of complete responsibility for the design, manufacture and performance of the rail pads.

2. Submit inspection and test plan and procedures.

3. Retain packaging procedures.

4. Statement of the manufacturer's capabilities to carry out the work in accordance with the technical and quality assurance/control requirements.

5. Testing facilities certifications.

6. Delivery procedures.

B. Miscellaneous Hardware:

1. Retain shop drawings detailing the hardware to be furnished for the Work.

2. Submit prequalification test results for review or prequalification test plans to include:

   a. Test procedures.

   b. Schedule of qualification tests to be performed.

   c. Name of independent test laboratory proposed to perform tests.

3. Retain production run test plans to include:

   a. Test procedures.

   b. Test reporting procedures.

4. Retain hardware manufacture quality assurance reports to include:

   a. Production run test reports.

   b. Packaging procedures.

C. Bumping Posts:

1. Provide full installation details and step-by-step procedures for installing the salvaged bumping posts in the field. The procedures shall be comprehensive, clear and concise, shall be written in clear English, and shall have drawings and illustrations to clearly demonstrate the various installation steps and operations.

D. Rail Lubricators:

1. Salvaged solar powered rail lubricator location is shown on the drawings.

1.5 QUALITY ASSURANCE/QUALITY CONTROL

A. General:

1. The CONTRACTOR shall include its inspection and testing plan for the work. The inspection and testing plan shall identify who, what, when and where in the process of design, production, assembly, shipment and acceptance that all inspections will be performed.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Rail Pads:

1. Rail pads shall be used between the rail and concrete ties to minimize water intrusion and tie abrasion of the rail seat area and to reduce impact and vibration effects on the track structure.

2. Rail pads may be manufactured by injection molding or by the extrusion process, using raw materials which conform to the raw material supplier's published data sheets. They shall be marked in a permanent manner to indicate manufacturer and pad identification.

3. Rail pads shall have a nominal thickness of 1/8 inch and shall have a minimum width equal to the base width of the rail (+1/8 inches). It shall be shaped or have indicators that will provide correct orientation during installation.

B. Miscellaneous Hardware:

1. All miscellaneous hardware shall meet the physical dimensions, strength and properties and test requirements as defined herein.

2. The hex head bolts shall be used for embedding into concrete with or without epoxy grout and shall consist of the minimum dimensions required for the particular use. The hex head bolt shall be capable of withstanding the ultimate torque requirement necessary to destroy the diameter bolt as specified in ASTM A325. The ultimate tensile strength of the hex head bolt itself shall equal or exceed the tensile strength of 56,380 pounds as specified in ASTM A325.

3. Circular holes for joint bolts shall be drilled to conform to the drawings. A variation of nothing under and 1/16 inch over in the size of the bolt holes will be permitted. A variation of 1/32 inch in the location of the holes will be permitted. Chamfer the entrance and exit sides of the holes.

4. Miscellaneous heat-treated carbon-steel track bolts and carbon-steel nuts shall be in accordance with Section 2.9 of the 2006 AREMA Manual for Railway Engineering. Miscellaneous spring washers shall be in accordance with Section 2.10 of the 2006 AREMA Manual for Railway Engineering.

C. Bumping Posts:

1. CONTRACTOR shall salvage and relocate existing fixed hydraulic bumping posts to locations as shown on drawings.

PART 3 – EXECUTION

3.1 QUALIFICATION TESTING

A. Rail Pad:

1. Completed rail pads shall be clean, smooth and free of voids, sinking, gassing, laminations, cracks, burning and striations. Edges shall be well finished, and any sprue and flashes shall be cleanly cut off.

2. From a lot not less than 10 pads produced, three pads shall be selected at random for laboratory testing. Tie pad tests shall be conducted using a tie block as described in Section 2.5 Tie Pads of the 2008 AREMA Manual for Railway Engineering, Chapter 30. Tie pad tests shall follow the test procedures described in Section 2.5.1 Test 4A: Tie Pad Test (2006) and Section 2.5.2 Test 4B: Tie Pad Attenuation Test (2006) shall also be conducted following the Sequence of Design Tests as specified in Section 4.9.1.3 of the 2006 AREMA Manual for Railway Engineering, Chapter 30.

3. A certificate of conformity shall be presented for each batch of rail pads produced. Certificates of Conformity shall be included with the test reports previously referred to above.

B. Miscellaneous Hardware:

1. Hardware Production Test Requirements:

a. The CONTRACTOR shall submit mill certificates on the chemical and mechanical properties of the material supplied for the manufacture of the hardware.

b. The hex head bolts and lag screws shall be subjected to and meet the pre-qualification test acceptance criteria as specified in ASTM A325.

c. The hex head bolts and lag screws shall be subjected to and meet the production run test acceptance criteria as specified in ASTM A325.

2. Coating:

a. All hex head bolts shall be coated in accordance with ASTM B633, Type II (Olive Drab) Fe/Zn.

b. All other designated hardware shall be galvanized in accordance with the applicable ASTM specifications.

C. Bumping Posts:

1. Bumping posts shall be salvaged and relocated to the locations detailed in the Contract drawings.

D. CONTRACTOR shall test the salvaged rail lubricator for proper working conditions.

3.2 PACKAGING, LABELING, AND STORAGE

A. Rail Pads:

1. Completed rail pads shall be packaged in single PVC bags of 100 pieces each and packed in wooden crates of 4,000 pieces each for shipment to the designated site location.

B. Miscellaneous Hardware:

1. The hardware shall be manufactured, transported and stored so that no physical damage occurs to the threads. The hardware shall be packaged in equal quantities and in accordance with commercial practice for preservation and packaging.

2. Shipment marking information shall be provided on the exterior of delivery containers. The information shall include nomenclature, manufacturer's name and part catalog number, contract or order number, and destination. Each pallet shall not exceed 2000 pounds in weight and each pallet shall clearly show the quantities on each pallet.

C. Bumping Posts:

1. CONTRACTOR shall salvage and relocate existing fixed hydraulic bumping posts to locations as shown on drawings.

END OF SECTION

Division 34 – Transportation
Section 12 – Commuter Rail Transit (CRT)

SECTION 34 12 23

CRT – SPECIAL TRACKWORK

PART I - GENERAL

1.1 SUMMARY

A. Description

1. This Specification defines the requirements for the design, detailing, manufacturing, fabricating, furnishing and delivery of the mainline and industry track special trackwork.

B. Related requirements

1. Section 34 12 24 – Trackwork – Special Trackwork
2. Section 34 12 36 – Timber Ties
3. Section 34 12 35 – Concrete Ties
4. Section 34 12 27 – Trackwork – Ballasted Track Construction
5. Section 34 12 45 – Trackwork – Field Rail Welding
6. Section 34 12 93 – Other Track Material

1.2 REFERENCES

A. Special trackwork shall be new and manufactured, fabricated, and inspected in accordance with the following current standards, except as modified herein.

Sponsor	Number	Subject
AREMA		Manual for Railway Engineering, and Portfolio of Trackwork Plans
ASTM	A 27	Steel Castings, Carbon for General Application
ASTM	A 47	Ferrite Malleable Iron castings

ASTM	A 128	Steel Castings, Austenitic Manganese
ASTM	A 325	High-Strength Bolts for Structural Steel Joints
ASTM	A 490	Heat-Treated Steel Structural Bolts, 150 ksi minimum tensile strength
ASTM	B 633	Electrodeposited Coatings of Zinc on Iron and Steel
ASTM	D 217	Standard Test Method for Cone Penetration of Lubricating Grease
ASTM	D 566	Standard test Method for Dropping Point of Lubricating Grease
ANSI	B 18.2.1	Square and Hex Bolts and Screws
ANSI	B 18.21.1	Lock Washers
ANSI	B 18.22.1	Plain Washers

B. The scope of work shall include all rail and associated components. Supports and brackets for the switch machines shall be supplied by the switch machine manufacturer.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions except as modified herein.

B. Submit or retain the following:

1. Submit interface drawings addressing the attachment of the switch and detector rods to the special trackwork, prepared by the Contractor and approved by the switch machine manufacturer.

2. Retain full installation details and step-by-step procedures for installing the special trackwork in the field. The procedures also shall address the interface requirements for the installation of the switch machine.

3. Submit maintenance and operating manuals to outline step-by-step procedures and details for inspecting and maintaining the special trackwork by maintenance personnel during service. The manuals shall address all routine inspection, frequency of inspections, dimensional checks, safety issues, and repair procedures associated with the proper maintenance of the special trackwork components. The manuals shall be written in comprehensive, clear, and concise English with graphic descriptions.

1.4 QUALITY ASSURANCE

A. Quality assurance/quality control shall be in accordance with the requirements of the Quality Plan and the General Provisions except as modified herein.

B. Review fabrication drawings, per the General Provisions, showing details of each special trackwork component, its proper position in the overall layout, and fabrication and fit tolerances.

1.5 ACCEPTANCE

A. The throw forces of all switch points, including all acceptance tests at the plant, shall be measured and documented by the Contractor for the UTA's review. The Contractor shall furnish all equipment required for measuring and recording throw forces for production testing, with the exception of the one-time test using a switch point machine and a frog point machine supplied by others.

B. The Contractor shall select one switch point machine, together with throw rods and detector rods, and all other associated fittings and accessories, supplied by the switch machine supplier for testing. The switch machines then shall be installed under the switch machine supplier's supervision, and the throw forces shall be tested by the Contractor in conjunction with the switch machine supplier. The results of this test shall be recorded and submitted to the Engineer.

C. The results of all tests shall meet the parameters specified by the switch manufacturer.

1.6 SPARE PARTS

A. The Contractor shall prepare a list of recommended spare parts for all special trackwork components for acceptance by UTA. The list shall include necessary parts by identification number and recommended quantity, with current unit prices.

1.7 TOLERANCES

A. All fabrication tolerances shall conform with the track gauge of 4'- 8 1/2", +/- 1/16",

and a horizontal and vertical cross level tolerance of 1/16 inch measured in 6 foot chords.

B. All component and fit tolerances shall meet the applicable requirements of AREMA Standards.

C. All components shall be designed such that the specified tolerances can be maintained throughout the operational life of the special trackwork with minimal maintenance.

1.8 COMPATIBILITY WITH SWITCH MACHINES

A. Special trackwork and components shall be compatible with interface and operation of the designated switch machine manufacturer's model. Compatibility shall be confirmed by design and testing as specified herein.

B. n and testing as specified herein.

1.9 SPECIAL TRACKWORK GEOMETRY

A. All special trackwork geometry shall conform to the current standards of Union Pacific Railroad. No. 9, No. 11, No. 15, No. 20, and No. 24 turnouts along the mainline shall have curved split switch or tangential switch geometry with rigid point frogs.

B. All turnouts for UPRR spur tracks shall be minimum No. 9 turnouts with standard curved split switch or tangential switch geometry and fixed rigid frogs.

PART II - PRODUCTS

2.1 RAIL

A. Rail for special trackwork, including stock rail and closure rail, shall be 115 RE or 136 RE as shown on the Contract Drawings or established by the Engineer.

B. Stock rails shall be in accordance with UPRR Standard Drawings. Rails shall be cut square and clean by means of rail saws, shears or abrasive cutting wheels in accordance with the applicable current UPRR and AREMA standards. All jointed rail shall be developed from one continuous rail section.

C. Unless otherwise noted for thermite field welding, all rail ends shall be drilled for standard 6-hole joint bars in accordance with the current edition of AREMA Manual for Railway Engineering, Rail Drillings, Bar Punchings, and Track Bolts. Holes drilled in the rails shall be 1-1/8 inches in diameter and shall be peened or ground to remove all sharp edges.

2.2 SWITCH POINTS

A. Switch points shall be curved split type with uniform risers as per UPRR Standard Drawings, or approved equivalent. Switch points shall have reinforcing bars, drilled and assembled to the switch points by means of square head bolts and hex nuts.

B. Switch points shall have an undercut design in accordance with UPRR Standard

Drawings. Switch point stops shall bear against the supporting stock rails when points are in the thrown positions.

C. All switches shall be installed for interlocked power operation.

2.3 HEEL BLOCKS

A. Heel blocks shall be as specified by current UPRR Standard Drawings.

2.4 RAIL BRACES AND SLIDE PLATES

A. On ballasted track turnouts, AREMA Plan Basic Numbers 223 and 224 shall be modified as required to accommodate a boltless brace design.

2.5 GAUGE PLATES

A. Gauge plates shall be as indicated on the standard plans.

2.6 TURNOUT FROGS

A. Fixed rigid point turnout frogs shall be fabricated to the designated turnout number geometrics and shall be solid manganese steel frogs in accordance with current UPRR Standard Drawings.

B. Austenitic manganese steel castings shall be of a heavy wall thickness design in accordance with the requirements of ASTM A128, Grade A. Castings shall be explosive depth hardened in accordance with AREMA, Specifications for Special Trackwork, Article M2.7, with a minimum Brinell hardness of 350. Hardening shall project uniformly to 250 BHN at a depth of 1 1/8 inches.

C. The Contractor shall produce shop drawings to specify the procedures to be used for the depth hardening process, the portions of each frog which are to be depth hardened, and the Brinell hardness pattern which the Contractor anticipates to achieve with such procedures.

1. Frog guardrail shall consist of a tee rail design with single piece construction and level guardrail height. The ends of the guardrail shall be beveled and milled. The flangeway shall be the minimum width required for the proposed vehicle wheel profile. Foot guards shall be provided.

2. Tie plates shall be single rail plates either flat or canted as required by location.

3. Specially fabricated tie plates shall be provided with a 1:80 cant for use in transition areas between canted tie plates and flat special trackwork tie plates. A minimum of two such plates shall be provided at each transition section. Rail clips and anchors shall be of similar design to those used for standard plates.

4. Turnout plates shall be designed to accommodate the required turnout geometry and for use with an elastic rail clip system with welded on shoulders. The plates shall be insulated as required to conform with system electrical isolation requirements.

5. Switch rods shall be vertical insulated switch rods supplied by the switch

machine manufacturer.

2.7 INNER EMERGENCY GUARD RAIL

A. Rail clips for connection of the Inner Emergency Guard Rail shall be as indicated on the plans.

2.8 LUBRICATION

A. Lubricant for moving parts in turnouts shall meet the following requirements:

1. Calcium soap	9%
2. Graphite	11.5%
3. Penetration, ASTM D217 at 700 F worked	340
4. Dropping Point, ASTM D566 at 770 F	101/214
5. Oil viscosity, ASTM D445, cSt at 1040 F	81.8

B. Other types of lubricants may be used providing that the lubricant has been used successfully by the Union Pacific Railroad subject to Engineer's written statement of no objection.

2.9 RAIL JOINTS

A. Rail joints for special trackwork shall be thermite welded or by means of joint bars. Where a joint occurs in a guarded rail section of the turnout, a separator block shall be provided for the full length of joint bar in between the two rails.

B. Joint bars and separator blocks shall meet the requirements specified in Section 34 12 93 – Other Track Materials.

C. Insulated joints shall meet the requirements specified in Section 34 12 93 – Other Track Materials. Insulated joints located in single rails shall be of an epoxy glue design. Insulated joints located in guarded rail sections shall be a poly-encapsulated design.

2.10 SWITCH TIES

A. Switch ties in ballasted track sections shall meet the requirements specified in Section 34 12 35 – Concrete Ties or 34 12 36 – Timber Ties and AREMA Chapter 30.

PART III - EXECUTION

3.1 DETAILED DESIGN

A. The Contractor shall develop all required details in accordance with these specifications and industry standards. Detailed shop drawings shall be provided by the Contractor for all components including but not limited to frogs, switches, closure rails, restraining rails, rail fastener plates, and fastener layouts. The Contractor shall

address the following considerations in the design of special trackwork:

1. Tie Layouts - Detailed crosstie layouts to support the special trackwork in ballasted track with the exact location and length of each tie shown.

2. Dimensions - All dimensions shall be confirmed in the field with respect to locations where the new special trackwork must tie into existing tracks. The location of existing joints and the amount of wear on existing rails shall be determined so that the location of joints can be detailed on the shop drawings.

3.2 HANDLING AND DELIVERY

A. All rails and special trackwork shall be handled carefully and delivered in open top containers to avoid damage by kinking, bending, nicking, or other potential damage to the rail. Rails and special trackwork components shall not be dropped or struck sharply. Handling and delivery shall be in accordance with current AREMA standards.

B. Stock rails, closure rails, tongue rails, and frogs shall be delivered assembled with associated fasteners attached.

C. Small loose parts and miscellaneous hardware shall be delivered in secure boxes and kegs, each weighing not more than 80 pounds.

D. All bundles, boxes and kegs shall be clearly marked with the following information:

1. Identification of items contained

2. Supplier’s name

3. Delivery date

4. Number of pieces

5. Gross weight

END OF SECTION

SECTION 34 12 24

CRT – TRACKWORK – SPECIAL TRACKWORK

PART I - GENERAL

1.1 SUMMARY

A. Description

1. This Section specifies the installation of new ballasted track turnouts and crossover units as shown on the Contract Drawings and as specified herein.

2. This section also includes the removal of existing ballasted track turnouts and crossover units as shown on the Contract Drawings and as specified herein. Turnouts not to be relocated will be salvaged.

3. The mainline track is standard and head hardened 115 RE rail, except at turnouts and UPRR connections, which are 136 RE rail.

4. Powered turnouts have switch heaters installed with gas service or electric line from meter on the wayside.

5. All turnouts shall be welded.

B. Related requirements

1. Section 34 12 32 - Ballast

2. Section 34 12 36 - Timber Ties

3. Section 34 12 35 - Concrete Ties

4. Section 34 12 23 - Special Trackwork

5. Section 34 12 45 - Trackwork - Field Rail Welding

6. Section 34 12 27 - Trackwork - Ballasted Track Construction

7. Section 34 12 93 - Other Track Material

1.2 REFERENCES

Sponsor	Number	Subject
AREMA		Manual for Railway Engineering
AREMA		Portfolio of Trackwork Plans
ASTM	A 325	High Strength Bolts for Structural Steel Joints

ASTM	E 10	Test Method for Brinell Hardness of Metallic Materials

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein.

B. Installation procedure for glued insulated rail joints.

C. Rail end hardening procedures and test results.

D. Switch heater layout and shop drawings for each turnout. Including layout of the relocated heater ducts, a listing of new items necessary to incorporate the existing (relocated) switch heaters into the work, if applicable.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART II - PRODUCTS

2.1 MATERIALS

A. Materials Furnished by UTA

1. Refer to the General Provisions for Owner furnished materials.

B. Materials Furnished by Contractor

1. Except for those materials furnished by UTA, the Contractor shall furnish all material required to construct special trackwork, including but not limited to those materials listed below. All materials shall be new material, unless otherwise indicated.

a. Trackwork

1) Ballast: Shall conform to the requirements of Section 34 12 32 – Ballast.

2) Applicable materials specified in Section 34 12 23 – Special Trackwork.

3) Any and all other material not provided by UTA to provide a complete installation.

b. High Pressure Natural Gas Switch Heaters

PART III – EXECUTION

3.1 GENERAL

A. Special trackwork shall be constructed as shown on Contract Drawings and in accordance with the requirements of AREMA Specifications, and AREMA Manual and Portfolio of Trackwork Plans and Section 34 12 23 – Special Trackwork, except as modified herein.

3.2 INSTALLATION OF SPECIAL TRACKWORK

A. Switch Ties: Special trackwork in mainline track shall be installed on new switch ties.

B. Ballast: Ballast shall be dressed to the indicated cross sections, including walkways, one inch below the top of tie except that the top of ballast shall be depressed three inches below top of switch tie between the point and heel of all switches.

C. Tamping: Tamping shall be uniform under the rails throughout the length of each switch tie utilizing the ballast compaction procedures specified in Section 34 12 27 – Trackwork – Ballasted Track Construction.

D. Switch Lubricant: Slide plates shall be lubricated with a dry graphite, insulating film-type lubricant such as Dixon 500 or approved equal.

E. Adjustments: Manual switches shall be adjusted for complete and easy hand throw to both the normal and reverse positions.

F. Work Trains: Work trains shall not be operated over Special Trackwork until ties have been properly placed and rails set in position, cross leveled, brought to line to prevent damage.

G. Head-Driven Bolts: Bolts shall be installed in the joint bars, as per manufacturer's recommendations and/or requirements, to secure a tight fit. Joint bar head driven bolts shall be applied with their heads alternately inside and outside of the rail. Tightening of the bolts shall be from the center of joint working both ways to the end of the joint. As a protection against rust, all joint bars and the parts of rail covered by joint bars shall be painted with a metal preservative, No. OX ID Grade A Special or approved equal.

H. Field Rail Welding: Join rails together by field welding as indicated on the Contract Drawings. Adjust field welding procedures as required for welding of premium rail. Field rail welding shall be performed in accordance with Sections 34 12 27 – Trackwork – Ballasted Track Construction and 34 12 45 – Trackwork – Field Rail Welding.

I. Bonded Insulated Rail Joints: Field fabricated and preassembled bonded insulated rail joints shall be installed at locations shown on the Contract Drawings, in conformance with the requirements of Section 34 12 93 – Other Track Material. Bonded insulated joints shall be tested in conformance with the requirements of Section 34 12 93 – Other Track Material.

J. Signals: Signal bonds shall be installed as shown on Contract Drawings and in accordance with the requirements of Section 16450.

K. Bolting: Frogs of turnouts and crossings shall be bolted as shown on the Contract Drawings. Connection shall be a six-bolt connection.

L. Final Alignment

1. The final surface and alignment of the special trackwork to be within the tolerances specified for ballasted mainline track in Section 34 12 27 – Trackwork – Ballasted Track Construction.

2. After final surfacing and aligning, dress the ballast to conform to the ballast sections indicated.

3. In the event that subballast outside the toe of the slope is fouled or disturbed as a result of the Contractor's operations, re-slope those portions of the subballast and/or ballast at the Contractor's expense.

3.3 REMOVAL OF EXISTING SPECIAL TRACKWORK

A. Existing special trackwork units shall be removed from the locations shown on the Contract Drawings. Care shall be taken to not damage any of the special trackwork components. Special trackwork components damaged by the Contractor shall be replaced at the Contractor's expense.

B. Field saw cut or unbolt the rails as shown in the approved work plan and remove the special trackwork components from track. Field saw cut shall be not closer than 2'-0" from an existing weld or as approved by the Engineer.

C. The Contractor shall disassemble and clean the special trackwork unit components. All material and components shall be cleaned, free of rust and dirt, and lubricated as directed by the Engineer prior to reassembly of the special trackwork.

3.4 RAIL CUTS AND END HARDENING

A. Straight rails shall be cut to fit the special trackwork components as shown or as required.

B. Rails shall be cold-sawed, square across the rail, with maximum $^{1}/_{32}$ inch deviation from square. All burrs shall be removed and ends made smooth. Beveling of rail ends is required at all bolted joints, conforming to Plan No. 1005-40 in the AREMA Portfolio of Trackwork Plans.

C. After cutting and beveling, rail ends shall be end hardened by a hardening process proposed by the Contractor which will provide a uniform hardness pattern across the top surface of the rail head for two inches from the end, except precurved rail shall not be end hardened. The Brinell hardness number when tested in conformance with ASTM E 10 shall be between 341 and 401, throughout the area within two inches from the end and shall decrease uniformly to the hardness of the untreated rail four inches from the end.

D. The Contractor shall submit a test of the hardening process, out of track, with Brinell hardness tested by an independent testing laboratory engaged by the Contractor and approved by the Engineer. Tests shall be made on the rail centerline and $^{3}/_{4}$ inch on each side of the centerline, starting at $^{1}/_{4}$ inch from the end and at four other cross sections 1 inch, 2 inches, 3 inches and 4 inches from the end. If the tests do not

indicate acceptable results, the procedure shall be modified and retests made until acceptable test results are achieved.

E. Holes for bolted joints shall conform to AREMA Rail Drillings, Bar Punchings, and Track Bolts; and be cylindrical, free from burrs, and with sharp edges removed. Templates that meet the hole tolerance specified in AREMA shall be used for hole drilling.

3.5 HIGH PRESSURE NATURAL GAS SWITCH HEATER

A. Natural Gas Switch Heaters

1. Natural Gas Switch Heaters shall be provided and installed in accordance with the manufacturer's guidelines.

2. Installation of 10-to-14 psi Natural Gas service line shall be coordinated by UTA with local gas company.

B. Installation of Gas Line Fuel Line: Install pipe and fittings and connect to meter and switch heater in accordance with gas company standard practices. Use steel pipe for riser pipe at meter but use polyethylene pipe for fuel service line to the switch heaters. Install an unbroken No. 14 or heavier copper wire or plastic marking tape with metallic wire over each pipe to provide for location.

3.6 ELECTRIC SWITCH HEATER

A. Electric Switch Heaters

1. Electric Switch Heaters shall be provided and installed in accordance with the manufacturer's guidelines.

2. Installation of Electric service line shall be coordinated by UTA with local electric company.

B. Installation of Electric Line: Install line and connect to meter and switch heater in accordance with electric company standard practices.

END OF SECTION

SECTION 34 12 27

CRT – TRACKWORK - BALLASTED TRACK CONSTRUCTION

PART I - GENERAL

1.1 SUMMARY

A. Description

1. This Section specifies the construction of ballasted mainline tracks on concrete ties, installing single and double inner emergency guard rails on concrete ties, and inspecting track geometry by inspection car, as shown on the Contract Drawings and as specified herein.

2. Ballasted mainline track shall be fully welded with new 115 RE rail. Turnouts and crossovers shall be welded. Ballasted mainline track shall be constructed on concrete ties spaced at 28-inch centers.

3. Industry trackwork to be performed by contractor shall be fully welded 136 RE rail.

B. Related requirements:

1. Section 34 12 34 – Rail Handling and Storage

2. Section 34 12 32 – Ballast

3. Section 34 12 31 – Subballast

4. Section 34 12 36 – Timber Ties

1.2 REFERENCES

Sponsor	Number	Subject
AREMA		Manual for Railway Engineering, Volumes I and II and Portfolio of Trackwork Plans
UTA		Utah Transit Authority Design Criteria, Revision X, Month 2024

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein. Submittals shall include:

1. Designation of line and profile rail.

2. A report with detailed description of installation procedures required for the work specified in this Section.

3. Working Drawings, including the following:

    a. Complete details for distributing CWR, including a rail schedule.

    b. Complete details of the proposed methods, including equipment, of laying and fastening CWR and bolted rail.

    c. Location of proposed field cuts and field welds in CWR on the rail schedule.

4. Ballast tamping procedure.

5. Superelevation tag detailed drawing showing dimensions, material and stamped (or embossed) information, and the method for fixing the tag to the track support structure.

6. Track Inspection Car

    a. Submit make, model and catalog data.

    b. Submit copy of data output.

7. The equipment proposed for vibrating the rail.

8. The method and equipment proposed for achieving zero thermal stress in the rail.

1.4 QUALITY ASSURANCE

A. The Contractor shall implement a comprehensive quality assurance program to assure that the Work is performed as specified in the Contract Documents.

B. The Contractor's Quality Assurance program shall be supervised by designated persons qualified to supervise the Work.

1.5 ACCEPTANCE

A. Not Applicable.

PART II - PRODUCTS

2.1 MATERIALS

A. Materials Furnished by UTA: The following materials shall be furnished by UTA. Any material remaining upon completion of the trackwork shall be transported to the UTA's storage site designated by the Engineer, within one mile of the Contract limits, and unloaded in accordance with Special Provisions. All materials are new material, unless otherwise indicated.

B. Materials Furnished by Contractor: Except for those materials furnished by UTA, the Contractor shall furnish all material required to construct trackwork, including but not

limited to those materials listed below. All materials shall be new material, unless otherwise indicated.

1. Rail: New 115 RE and 136 RE rail.
2. Concrete Crossties: Type 1 for mainline track furnished with rail clips, clip insulators and rail seat pads.
3. Guard Rail (new or secondhand rail)
4. Guard Rail Crossties.
5. Grade Crossing Crossties.
6. Grade Crossing Panels.
7. Timber crossties: Type for mainline track furnished with rail clips, clip insulators and rail seat pads.
8. Ballast and subballast.
9. Superelevation Tags: Tags used to mark the superelevation on curved track shall be made of a corrosive resistant metal such as anodized aluminum or brass. Tags shall be stamped in $^1/_4$ inch increments from zero superelevation to maximum superelevation. Fractions shall be stamped a minimum of 2 inch in height. Tags shall be a minimum of 0.050 inch thick, 1-$^1/_4$ inches wide and two inches long. Tag dimensions, materials and manufacture shall be submitted for approval.
10. Any and all other material not provided by the UTA to provide a complete installation.

PART III - EXECUTION

3.1 GENERAL

A. Track construction shall conform to AREMA Specifications for Track Construction except as modified herein.

B. Ballasted mainline track shall be constructed with new concrete crossties and 115 RE continuous welded rail (CWR) unless specified otherwise. Concrete ties shall be supplied with Pandrol USA “FAST CLIP” pre-assembled in parked position.

3.2 TRACK TYPES

A. The Contractor shall construct the types of track as shown on the Contract Drawings.

3.3 EXISTING FACILITIES

A. The Contractor shall conduct his trackwork operations to avoid damage to ballast, subballast, ditches, drainage structures, fences, existing utilities, and other existing infrastructure. The Contractor shall be responsible for coordinating his work with the

other contractors in the area. All damages to existing facilities shall be repaired by the Contractor at his own expense.

3.4 TRACK ALIGNMENT AND GEOMETRY

A. General: The track shall be constructed to the alignment and profile indicated, or as adjusted by the Engineer, within the tolerance specified. The track centers between UTA and existing UPRR is 25' minimum, except at defined pinch points. The Contractor shall field fit the track to accommodate 25' minimum track centers, or minimum track center defined at pinch points as detailed on the Contract drawings.

B. Profile Rail: The Contractor shall designate right or left rail, while facing in the direction of increasing stationing, to control the grade of all tangent tracks on a Contract-wide basis. Low rail on all curves shall be used as grade control.

C. Line Rail: The Contractor shall designate right or left rail, while facing in the direction of increasing stationing, to control the alignment of all tangent tracks on a Contract-wide basis. Centerline on curves shall be line rail.

D. Superelevation: Track superelevation shall be accomplished by maintaining the inside rail of a curve at top of rail profile and raising the outside rail to required superelevation. Runoff of superelevation shall be accomplished linearly throughout the length of the spiral transition curve and elsewhere as indicated on the Contract Drawings. Superelevation tags shall be installed on concrete ties for each $^1/_4$ inch of rise and attached with approved epoxy cement. Superelevation tags shall be furnished and installed by the Contractor.

3.5 TOLERANCES

A. Deviations from indicated gauge, cross level, horizontal line, profile grade, and tie spacing shall conform to the following requirements:

1. Gauge

   a. Tangent mainline track gauge shall be 4'-8-$^1/_2$", plus or minus $^1/_8$ inch. For #20 turnouts, the gage shall be as follows:

   b. When thrown for straight movement, #20 Point Gage through the machined area (PS + 20' 8") should be 4' 8-3/4" plus or minus 1/8", and will transition back incrementally to normal gage within said 20' 8".

   c. When thrown for reverse movement, #20 Point Gage through the machined area (PS + 20' 8") should be 4' 8-3/8" plus or minus 1/8", and will transition back incrementally to normal gage within said 20' 8".

2. Curved mainline gauge shall be to the same tolerances listed in 3.5.A.1 above, and shall be as follows:

Curve Radius	Track Gauge
Tangent to 500 feet	4 feet 8-$^1/_2$ inches

Below 500 feet	4 feet 8-3/4 inches

a. Variations in gauge shall not exceed 1/8 inch per 31 feet of track.

3. Cross Level and Superelevation

   a. Mainline track cross level shall be plus or minus 1/8 inch from level on tangent or design superelevation on curve.

   b. Variations in cross level and superelevation shall not exceed 1/8 inch per 31 feet of track.

4. Deviation from Horizontal Alignment: For mainline tracks, deviations are as follows:

   a. Plus or minus 1/8 inch in 62-foot chord.

   b. Plus or minus 2 inch total except in road crossings and passenger stations where total deviation shall be plus or minus 1/4 inch. Total deviation is measured between the theoretical and actual alignments at cumulative points within the 62' chord of the track.

5. Deviation from Horizontal Spiral Curves: Mid-ordinate of 62-foot chords, with half-chord overlaps, shall not vary by more than plus or minus 1/8 inch from straight line rate of change.

6. Deviation from Profile Grade: Deviation from profile grade shall not exceed plus or minus 1/8 inch in a 62-foot chord or a total of plus or minus 2 inch, except at station areas where the total deviation shall not exceed plus or minus 1/4 inch. Total deviation is measured between the theoretical and actual alignments at cumulative points.

7. Tie Spacing

   a. Distance between centerline on adjacent ties shall not vary more than plus or minus one inch from the indicated spacing.

   b. Concrete crossties in mainline track shall be spaced 28 inches on centers.

   c. Ties shall not be placed closer than three inches from any field rail weld.

8. For minimum ballast depths, refer to the Contract Drawings. Measurement shall be from the bottom surface of the crosstie to the top surface of the subballast, taken at the location of the running rail closest to the subballast.

3.6 TOOLS AND EQUIPMENT

A. Track gauge, flangeway width, curve radii, rail sections and special trackwork components are designed for passenger rail vehicle operations as well as freight and are as specified herein and indicated on the plans. The width of flangeway for all frogs and frog guard rails to AREMA standards of 1-7/8 inches.

B. Clearance for the Contractor's on-track equipment shall conform to the requirements for vehicle clearances for standard freight operations.

C. Contractor's equipment shall not exceed the design loads of Cooper E-80. Further information concerning vehicle characteristics will be provided by UTA upon request by Contractor. Contractor shall verify that proposed equipment meets these requirements.

D. Tools used in track construction shall conform to AREMA Specifications and Plans for Track Tools or approved equal. All tools shall be calibrated as appropriate for use.

3.7 PLACEMENT OF INITIAL BALLAST LAYER

A. An initial layer or layers of ballast shall be uniformly distributed over the finished subballast and compacted before tie distribution, or as otherwise agreed to with the Engineer. Subballast fouled or disturbed by the Contractor's operations shall be repaired by the Contractor at no additional cost to UTA. No ballast shall be placed until the prepared subballast surface has been accepted by the Engineer subsequent to a joint inspection by the Contractor and the Engineer. The initial layer of ballast shall be limited to a total compacted depth that will establish the track surface at least four inches below final grade.

B. Each lift of ballast within the initial layers shall be uniformly spread and compacted with not less than four passes of a vibratory compactor with the following characteristics:

1. Gross weight 5,000 pounds minimum
2. Drum width 58 inches minimum
3. Drum diameter 42 inches minimum
4. Dynamic load 18,000 pounds minimum
5. Load frequency 1,100 to 2,000 vibrations per minute

C. Each compacted lift within the initial layers shall not exceed a depth of four inches.

D. The compacting equipment selected by the Contractor shall be subject to inspection and acceptance by the Engineer.

3.8 CROSSTIE DISTRIBUTION

A. Except as modified herein and in Section 34 12 35 – Concrete Ties, concrete crossties shall be handled, transported and stored in accordance with the current AREMA standards.

1. Only approved lifting devices shall be used which will not damage the tie.
2. Crossties and switch ties shall be transported in a horizontal position and braced to prevent any movement that could cause damage.

B. The Contractor shall transport the ties from the storage area to the job site, where the ties shall be distributed and properly spaced on the compacted initial layer of ballast.

C. Ties shall be placed on a smooth, compacted surface as specified herein, spaced as shown on the Contract Drawings within specified tolerances, and laid normal to the centerline of track.

D. All ties shall be lifted and supported during storage, transportation, and placing in such a manner as to prevent damage. Ties damaged as a result of improper handling by the Contractor will be rejected by the Engineer and removed and replaced by the Contractor with undamaged ties meeting the specification requirements. The cost of the replacement tie(s) and the cost of removing the damaged tie(s) and transporting and installing the undamaged tie(s) shall be borne by the Contractor.

3.9 RAIL FASTENING

A. Mainline Track

1. Prior to applying rail seat pads, clean the tie contact surface to allow full bearing of the rail seat pad on the tie.

2. Center tie and place square to the centerline of the rail and install the rail seat pad.

3. CWR shall be placed on the rail seat in accordance with the approved Working Drawings, and shall not be dragged over or slid through the rail seat. Stone dust and extraneous materials shall be blown off thoroughly from the surface of the tie to prevent damage to the rail seat pad.

3.10 LAYING CONTINUOUS WELDED RAIL

A. Unload and lay CWR in a place and in a manner that prevents damage to the ties, rails and structures.

B. Lay opposite CWR strings in a manner which will result in a ten foot minimum stagger of welds, except as otherwise agreed to with the Engineer.

C. Make every effort to minimize or eliminate field cuts and field welds in CWR. Designate location in finished track by route name, stations of ends of rail string, and right or left rail as determined by facing in the direction of increasing stationing. Place all rail heat numbers on the same side of the CWR string.

D. Record the following information at the time of laying and anchoring CWR. Furnish copies of this documentation to the Engineer.

1. Location by station, track designation and rail.

2. Date and time.

3. Rail weight and section, mill brand, year rolled and the heat number of the end rails in each CWR string.

4. Length of CWR string in feet.
5. Ambient and rail temperatures.
6. Approximate weather conditions.
7. Adjustment applied (type and rail end movement).

3.11 RAIL TEMPERATURE

A. Determine rail temperature by means of an AREMA standard rail thermometer as specified in the AREMA Manual.

B. Place rail thermometers on the shaded side of the rail base next to the web and leave in place until no change in its reading is detected, but not less than five minutes.

C. Take rail temperature at the time of adjusting the gap between rail ends.

3.12 RAIL GAP

A. During rail laying below the indicated zero thermal stress temperature, determine the gap between CWR strings by using the equation:

   a. $G = (t - T) L K + Q$

   b. Where:

      1) G =Required rail gap (inches).

      2) t = Zero thermal stress temperature in degrees F. for type of track construction.

      3) T = Actual rail temperature at time of laying in degrees F.

      4) L = Length of rail in feet (one-half of the sum of lengths of the CWR string being laid and the preceding CWR string).

      5) K = Coefficient of thermal expansion for rail steel (0.0000065 inch per foot per degree F.).

      6) Q = Rail gap as required by manufacturer of field weld kit in inches.

3.13 ZERO THERMAL STRESS TEMPERATURE

A. Zero thermal stress temperature for open track shall be defined as a rail temperature between 93 to 108 degrees Fahrenheit when measured in accordance with paragraph 3.11.

B. The temperature of opposite rails shall be within 5 degrees Fahrenheit of each other.

3.14 TEMPORARY TRACK FASTENING

A. Temporarily fasten track for use of on-track equipment.

B. Prior to equipment being placed on newly laid rail, secure the rail in a manner that will prevent damage to trackwork materials.

C. Move equipment over newly laid rail in such a manner as to prevent damage to trackwork materials.

D. Temporarily fasten newly laid rail at not less than:

1. Every third tie on tangents and on curves having a radius greater than 1,900 feet.

2. Every other tie on curves having a radius of 1,900 feet or less.

3.15 SURFACING AND LINING

A. Track shall be surfaced and aligned as soon as possible after installing rail.

B. Lifts: Track shall be lifted a maximum of four inches by methods and equipment subject to approval of the Engineer. Undue bending of rail shall be prevented. Both rails shall be raised at one time and as uniformly as possible. Track shall be lifted so that it will be necessary to give it a final lift of two inches nominal to bring it up to grade. Ties that have been pulled loose shall be replaced to proper position, have a bearing against the rail and be secured. The Contractor shall exercise care during all ballasting operations to prevent center binding and damage to compacted subballast.

C. Alignment: The Contractor shall exercise care to protect track from being forced out of alignment by heat expansion and shall maintain full cribs at all times. Alignment shall be maintained during the lifting operations.

3.16 BALLAST COMPACTION

A. General: Vibratory squeeze-type tampers shall be used. Tools shall be maintained to manufacturer's specifications.

B. Requirements: Ballast shall be packed or tamped tightly under and around the tie from a point 18 inches inside each rail on both sides of the tie to the ends of the tie. Ballast around the center of the tie between the above limits shall not be compacted, but the center shall be filled lightly with ballast. Both ends of the tie shall be tamped simultaneously and tamping inside and outside the rail shall be done at the same time. Thorough tamping of the ballast under the rail seat is required.

C. Procedure Specification: The Contractor shall prepare for the Engineer's review a detailed tamping procedure specification covering tamping equipment and method. The specification shall include a complete description of equipment to be used and variables that can be adjusted such as:

1. Number of insertions of tamping tools per tie

2. Number of passes of tamping machine

3. Depth of penetration

4. Length of time tools remain down

5. Tamping guarded track

6. Tamping at transition slabs

D. Procedure Qualification: The Contractor shall qualify his tamping procedure specified herein as follows:

1. In the presence of the Engineer, the Contractor shall tamp 100 feet of track in accordance with his Procedure Specification.

2. The Contractor shall then remove three ties as required to enable the Engineer to observe the tamped ballast under the tie and determine conformance with requirements herein.

3. After inspection and approval by the Engineer, the Contractor shall replace the three ties and retamp.

4. Rejected Procedures: If tamping does not produce ballast meeting the criteria stated herein, tamping variables shall be adjusted and the Procedures Qualification repeated until criteria is met.

5. Production Compaction: The Contractor shall perform all production compaction in accordance with a Procedure Specification approved by the Engineer in accordance with requirements herein.

E. Spot Checks: The Engineer will spot check production compacting. The Contractor shall remove and reinsert two crossties per every 2500 feet of track as directed by the Engineer.

3.17 INSULATED JOINTS

A. Insulated joints shall be furnished and installed in accordance with the requirements of Section 34 12 93 – Other Track Materials, and as shown on the Contract Drawings.

3.18 ZERO THERMAL STRESS

A. When zero thermal stress is obtained, begin fastening rail immediately.

B. The method and equipment proposed for achieving zero thermal stress must be submitted to the Engineer for approval.

3.19 PERMANENT RAIL FASTENING

A. Adjust the CWR string lengths for the zero thermal stress temperature.

B. Vibrate the rail to relieve internal rail stresses and fully fasten the string.

1. Use vibrators, approved by the Engineer, to relieve internal rail stresses.

2. Do not strike rail with objects which might damage the rail surface.

C. Fasten CWR strings in a manner intended to ensure that there is no unfastened section of rail between fastened sections of the same string.

D. Temperature of a rail, when being fastened opposite a previously fastened rail, to be within 5 degrees Fahrenheit of the previously fastened rail's temperature at the time of its fastening.

E. Once zero thermal stress has been obtained, maintain the correct rail gap until the rail is fully fastened.

3.20 FIELD WELDING

A. Join CWR strings in the field by the field welding process in accordance with the requirements of Section 34 12 45 – Trackwork – Field Rail Welding. Do not field weld any of the following:

1. CWR string to CWR string

2. CWR string to special trackwork unit

3. Before track has been brought to final vertical and horizontal alignment

B. Weld Gap

1. At the time of field welding, ensure that the rail is at the designated temperature and establish the rail gap recommended by the manufacturer of the weld kit.

2. Should the rail gap on fastened CWR be larger than the weld manufacturer's recommended gap after the CWR strings have been readjusted for zero thermal stress, saw a length of rail from one end of one of the fastened CWR and insert a rail not less than 13' long to provide the recommended gaps for field welding.

3. At a location where the rail gap is smaller than the manufacturer's recommended gap, obtain the recommended gap by sawing a piece from one rail.

3.21 DOUBLE INNER EMERGENCY GUARD RAILS

A. Double inner emergency guard rails, for the protection of structures, shall be installed at locations shown on the Contract Drawings and as specified herein.

3.22 FINAL ALIGNMENT AND TRACK INSPECTIONS

A. The final horizontal and vertical alignment, gauge, cross level and superelevation shall be within the tolerances specified. To determine the acceptability of all finished trackwork immediately after construction, the Contractor shall furnish and operate a rail-mounted track inspection car capable of measuring the parameters specified above with sufficient accuracy to establish that the track construction is within the tolerances specified herein. All inspections shall be made in the Engineer's presence.

B. Results of the track geometry inspection shall be in a format that will allow the identification and location of defects easily. Stationing shall be utilized and shall be

identical to that shown on the Contract Drawings. Contractor shall provide a strip chart and defect exception printout report.

C. Track geometry deviations, as disclosed by the inspection car specified above, shall be corrected and necessary reinspection shall be performed to ascertain that corrections have been made prior to final acceptance.

END OF SECTION

SECTION 34 12 31

CRT – SUBBALLAST

PART I - GENERAL

1.1 SUMMARY

A. Description

1. The work in this Section covers the furnishing and placing of subballast to conform to the finish grades and sections shown on the Contract Drawings or established by the Engineer.

B. Related requirements

1. Section 34 12 27 – Trackwork – Ballasted Track Construction
2. Section 34 12 32 - Ballast
3. Section 34 12 24 – Trackwork – Special Trackwork

1.2 REFERENCES

Sponsor	Number	Subject
AREMA	Chapter 1 Part 2.11	Subballast and Specifications
UDOT	02721	Untreated Base Course (UTBC)
ASTM	D 75	Sampling Aggregates
ASTM	C 17	Materials Passing No. 200 Sieve
ASTM	C 136	Sieve Analysis
ASTM	D 2922	Density Testing
ASTM	D 1557	Moisture-Density Relationship of Soils using a 10# Rammer
ASTM	C 136	Sieve Analysis of Fine and Coarse Aggregate
ASTM	D 1140	Test for Amount of Materials in Soils Finer Than
ASTM	C 88-90	Standard Test Method for Soundness of Aggregate by use of Sodium Sulfate

ASTM	C131-89	Standard Test Method for Resistance to Degradation of Small size Course Aggregate by Abrasion and Impact in the Los Angeles Machine

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein.

B. Submit a written job-mix gradation for approval before production, including single values for each sieve size based on the dry weight of the aggregate.

C. The Contractor shall furnish samples of the material proposed for use as subballast and identification of material source sufficiently in advance to obtain approval by the Engineer not less than 30 days prior to anticipated date of commencing installation.

1.4 QUALITY ASSURANCE

A. Source of Materials

1. Obtain approval of subballast by the Engineer prior to commencing installation.

2. Material or source of supply shall not be changed without approval of the Engineer.

3. Acceptance of subballast will be based on periodic samples taken following mixing.

B. Inspection

1. The Engineer may stop delivery of material to the job site based on visual inspection pending sampling and testing.

2. If material loaded, being loaded or installed does not conform to specified requirements, the Engineer will reject the material and no further delivery will be accepted until the deficiency is corrected.

3. Unless otherwise permitted by the Engineer, remove rejected materials from the site within 48 hours of rejection. Materials shall be removed at Contractor's expense.

4. Compaction will be subject to the tests specified herein.

C. Allowable Tolerances

1. Construct subballast to the following tolerances:

a. Vertical: Within $+1/2$ inch or -1 inch of elevation shown. Deviation not to exceed $1/4$ inch in 16 feet.

b. Horizontal: Within +3 inches or 0 inch of the limits shown.

c. In two or more lifts of approximate equal thickness. The maximum compacted thickness of any one lift shall not exceed 6 inches and shall be compacted to not less than 95% of maximum density.

2. During compaction maintain moisture content within 2% of optimum moisture content; as determined by ASTM D 1557 (latest revision).

1.5 ACCEPTANCE

A. Not Applicable.

PART II - PRODUCTS

2.1 MATERIALS

A. Subballast

1. Subballast shall be natural or crushed rock or gravel which conforms to the requirements of Utah Department of Transportation (UDOT) latest revision Standard Specifications Section 02721, except as modified herein.

2. Subballast shall be reasonably free from flat, elongated, soft or disintegrated pieces, plant material, or other deleterious matter occurring in a free state or as a coating on the stone.

3. The subballast material shall have:

a. No more than approximately 10% freeze thaw loss when tested in accordance with ASTM C 88-90.

b. No more than 50% loss when tested in accordance with ASTM C 131-89.

B. Gradation Requirements

2.1 The subballast shall be uniformly graded from coarse to fine and shall conform to the requirements of UDOT Standard Specifications Section 02721-2.1 B. Table 2 for base aggregate, specifically 1” for UTA. For UPRR use gradation matching the current UPRR Engineering Standard 0010.

PART III - EXECUTION

3.1 PLACEMENT

A. Prior to the Contractor beginning work to install subballast, the Engineer and the Contractor shall make a joint inspection of the trackway subgrade for acceptance.

B. All unacceptable areas of subgrade shall be repaired. All work shall conform to the requirements of applicable sections of Division 31 - Earthwork.

C. Prior to the placement of subballast material, the surface of the trackway subgrade stabilization layer shall be parallel the design grade and cross-section for the finished

surface within 0.04 foot. Placement of subballast material shall conform to the requirements of this Section 34 12 27 – Trackwork – Ballasted Track Construction, except as modified herein.

D. Place layers in equal thickness and compact each layer to a thickness not to exceed 6 inches in depth.

3.2 TESTING

A. Testing shall be performed by the approved testing lab selected and managed in accordance with the General Provisions. Quality assurance tests may be performed by the Engineer to ensure compliance with this Specification.

B. In-place density will be determined in accordance with ASTM D 2922. Testing will be performed every 200 lineal feet of route. In addition to density testing, or in lieu of as the Engineer elects, each compacted layer will be observed for deflection or reaction under moving loaded equipment to verify that no soft or pumping areas remain in any layer or foundation soil.

C. Compaction required will be 95-percent in accordance with ASTM D 1557.

D. Gradation testing shall be performed on every 500 tons of delivered Material and in accordance with the requirements of ASTM C 136.

3.3 CARE OF WORK

A. Following installation of the subballast, the Contractor shall do such work as the Engineer determines necessary to prevent or repair segregation, raveling and other damage or displacement, regardless of the cause, and to maintain the layer to specified condition until it is covered with a following layer to specified condition or course or until all Contract work is completed. Prevention may include, as determined by the Engineer, prohibiting or limiting construction traffic from the prepared subballast surface. Materials no longer meeting Paragraphs 2.1.A and B of this Section shall be removed from the job site and replaced by the Contractor at no expense to the UTA.

B. After acceptance by the Engineer, the Contractor becomes responsible for all future repairs necessary to the subballast until the project is completed. No additional payment will be made for future repairs to subballast.

C. The Contractor shall not proceed with the distribution and placement of any materials such as ballast, crossties, rail or other track material on the prepared subballast surface until the prepared subballast surface has been accepted by the Engineer subsequent to a joint inspection by the Contractor and the Engineer.

END OF SECTION

SECTION 34 12 32

CRT – BALLAST

PART I - GENERAL

1.1 SUMMARY

A. Description

1. This Section specifies the furnishing and installation of mineral aggregate for ballast on constructed subballast or bridge deck as shown on the Contract Drawings and as specified herein.

B. Related Requirements:

1. Section 34 12 37 - Concrete Grade Crossing Panels
2. Section 34 12 31 - Subballast
3. Section 34 12 27 - Trackwork - Ballasted Track Construction
4. Section 34 12 24 - Trackwork - Special Trackwork

1.2 REFERENCES

Sponsor	Number	Subject
AREMA	Chapter 1, Part 2	Ballast
ASTM	C 29	Test Method for Unit Weight and Voids in Aggregate
ASTM	C 88	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM	C 117	Test Method for Material Finer Than No. 200 Sieve in Mineral Aggregates by Washing
ASTM	C 127	Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM	C 136	Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM	C 142	Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM	C 535	Test Method for Resistance to Degradation of Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM	C 702	Method for Reducing Field Samples of Aggregate to Testing Size
ASTM	D 75	Practices for Sampling Aggregates
ASTM	D 4791	Standard Test Method for Flat or Elongated Particles in Coarse Aggregate

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein.

B. Identification of testing service, their testing program, and copy of their agreement with Contractor.

C. Testing laboratory test report.

D. Quarry qualification test report.

E. Plan for handling and placing ballast.

1.4 QUALITY ASSURANCE

A. All laboratory testing shall be carried out as specified in the General Provisions at the expense of the Contractor. The testing service and their testing program and procedures shall be subject to the approval of the Engineer.

B. The Contractor shall submit a copy of his agreement with the Independent Testing Laboratory to the Engineer for approval. The agreement shall specify that the testing agency is directly responsible to the Engineer, that all subsequent communication between the testing services and the Contractor regarding the work under this contract shall only be through the Engineer, and that the agreement shall run for the duration of the contract and can only be terminated by the Engineer.

C. The Independent Testing Laboratory shall submit timely, professional test reports containing a description of each test, identification of test equipment along with current calibration certificates, an explanation of all deviations of test procedures, tabulations and/or plots of test results, the testing service's evaluation of the results, and sketches or diagrams necessary to clarify the test or results.

D. The Independent Testing Laboratory shall submit five copies of each test report to the Engineer. The Engineer will forward two copies to the Contractor.

1.5 ACCEPTANCE

A. Not Applicable.

PART II - PRODUCTS

2.1 MATERIALS

A. General: Ballast shall be quarried crushed rock with fractured faces composed of hard, strong and durable particles, free from injurious amounts of deleterious substances and conforming to the requirements of the following paragraphs.

B. Ballast Source: The Contractor shall select his ballast source to produce ballast in accordance with these Specifications. Do not change material or source of supply without prior approval of the Engineer.

C. Quality:

1. Deleterious material in the ballast shall not exceed the following amounts, as determined by the appropriate testing method listed:

   a. Minus 200 Sieve 1.0 Percent Maximum per ASTM C 117

   b. Clay Lumps 0.5 Percent Maximum per ASTM C 142

2. Wear of the material shall not exceed 28 percent when tested in accordance with ASTM C 535.

3. Loss shall not exceed 5 percent after 5 cycles when tested in accordance with ASTM C 88 for sodium sulfate soundness.

4. Absorption shall not exceed 2.0 percent in accordance with ASTM C 127.

5. Flat and elongated particles are not to exceed a weighted average of 5 percent by weight, as determined by ASTM D 4791. Nor are they to exceed a dimension ratio of 1:3, per AREMA 2.4.1.9.

6. Use of limestone, slag, river gravel or any material containing metallic ore or metallic residues is prohibited.

7. Sampling shall be done in accordance with ASTM D 75. Test samples shall be reduced from field samples by means of ASTM C 702.

8. Determination of weight per cubic yard shall be in accordance with ASTM C 29.

D. Gradation Requirements:

1. Gradation of ballast shall be determined by testing in accordance with ASTM C 136. All gradation tests shall include minus 200 sieve particle analysis in accordance with ASTM C 117.

2. Ballast to be installed in track shall conform to AREMA No. 4A gradation table 1-2-2 Recommended Ballast Gradations.

PART III - EXECUTION

3.1 HANDLING

A. Ballast shall be kept clean and free from segregation during handling and placing operations. The Contractor shall submit his plan for handling and placing ballast. This plan shall include source, type of equipment to be used, location of stockpiles and method of distribution. Storage sites for ballast are the complete responsibility of the Contractor. Care must be taken in retrieving material from stockpiles to avoid contamination with the underlying materials.

3.2 INSTALLATION

A. Ballast shall be placed, spread, compacted, tamped and dressed in accordance with Section 34 12 27 – Trackwork – Ballasted Track Construction. Ballast shall not be placed, spread, compacted, tamped and dressed until the subballast surface has been accepted by the Engineer subsequent to a joint inspection by the Contractor and the Engineer.

3.3 INSPECTION

A. Ballast is subject to inspection and testing (gradation and quality) as often as considered necessary by the Engineer. Ballast which does not conform to this Specification shall not be used and the Engineer will notify the Contractor to stop further ballast operations. Ballast operations shall not resume until the fault has been corrected and defective material has been disposed of by the Contractor without cost to UTA.

B. Make provisions for the Engineer to have free entry to the producing plants at all times while the work of this Contract is being executed.

C. Provide the Engineer all reasonable facilities to ensure that the ballast is being prepared and loaded in accordance with the specifications.

D. Ballast samples will be collected at the point where the contractor takes ownership of the material.

3.4 TESTING

A. Qualification Testing

1. Ballast at the quarry shall be qualified prior to production. The Contractor shall have representative samples taken, tested for quality and gradation and certified by the approved testing laboratory.

2. Each stratum or portion of the quarry containing a variation in quality of stone shall be tested. Tests of a single stratum or portion shall not be averaged with any other stratum or portion of the quarry. Two samples shall be taken from each ledge or different quality of stone used in the preparation of the ballast.

3. Certificates shall be submitted not less than five (5) working days prior to start of production of ballast. Additional sampling and testing shall be performed if, in the Engineer's opinion, there are significant changes in the quarry operation.

B. Quality Control Testing

1. The approved testing lab will sample ballast and perform a minimum of one gradation test for every 1,000 cubic yards of ballast delivered to the job site to ensure uniformity and conformance with the gradation requirements. The test results will be submitted for the Engineer's approval within two (2) days of the time the test was performed.

2. Soundness tests will be performed in accordance with ASTM C 88 as required.

3.5 DEFECTIVE MATERIALS

A. Unless otherwise permitted by the Engineer, the Contractor shall remove rejected materials from the site within 48 hours of rejection. Materials shall be removed and replaced at Contractor expense.

END OF SECTION

SECTION 34 12 34

CRT – STANDARD AND HIGH STRENGTH RAIL

PART I - GENERAL

1.1 SUMMARY

A. Description

1. This Specification defines the requirements for the manufacture, supply, testing, and delivery of standard rail and high strength rail.

2. The quantity and type of rail to be welded by the Contractor includes all the rail required to construct the track as indicated in the Contract Drawings. Refer to Section 34 12 38 – Rail Welding and Section 34 12 45 – Trackwork – Field Rail Welding for welding requirements.

3. The Contractor shall assume full responsibility for the storage, security and issuance from stockpile of individual rail lengths or CWR during the period of the Contract.

B. Related Requirements

1. Section 34 12 38 - Rail Welding

2. Section 34 12 23 - Special Trackwork

3. Section 34 12 93 - Other Track Material

4. Section 34 12 27 - Trackwork - Ballasted Track Construction

5. Section 34 12 45 - Trackwork - Field Rail Welding

6. Section 34 12 24 - Trackwork - Special Trackwork

1.2 REFERENCES

Sponsor	Number	Subject
AREMA	Chapter 4	Rail
AREMA	Chapter 5, Section 5.2.3	Handling and Transporting Continuous Welded Rail
AREMA	Chapter 5, Section 5.1	Specification for Laying Rail

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein. Submittals shall include:

1. Detailed description of the steel metallurgy and the identity of each rail provided by heat ingot and letter.

2. A detailed description of the methods and procedures to be used to remove hydrogen in the steel.

3. A description of the ultrasonic testing method and equipment together with mill test report certificates of rails tested for this order.

4. A description of the method and verification testing to achieve the required rail hardness together with reports indicating the actual hardness achieved.

5. Quality Control Program description by the plant supplier of the rail.

6. Method of handling, shipping, unloading, and stacking rail from the time it is loaded onto the transporting vehicles at the rolling mill until it is to be stockpiled. This includes the method of dunnage support for rails and the stocking sequence for standard, high strength and pre-curved rail for mainline.

7. Rail processing reports and a rail list showing the heat, ingot and letter for every rolled rail including identification of the short rail, test rail, scrap rail, and similar information for informal review during the in-plant inspection in addition to formal submittal.

8. Rail test records, including mechanical properties tests, hardness measurements, ultrasonic test records and all other required test documentation, for informal review during the in-plant inspection in addition to formal submittal.

9. Ultrasonic Inspector's qualification certification for the individuals actually conducting the testing at least 30 days before the commencement of the in-plant inspection. hardness and mechanical properties of rails previously supplied to and accepted by others that were similar to the rails required under this Contract.

10. Layout for CWR production and storage of CWR and ties.

1.4 QUALITY ASSURANCE

A. The Contractor shall appoint a qualified QA representative(s) for inspecting the test reports and rail products supplied by the Contractor. All costs of such inspection shall be paid by the Contractor.

1.5 ACCEPTANCE

A. Not Applicable.

PART II - PRODUCTS

2.1 MATERIALS

A. The Contractor will furnish standard, and head hardened 115 RE rail and 136 RE rail as shown on the Contract Drawings and in accordance with the latest revision of the UTA Design Criteria and the current edition of AREMA Manual for Railway Engineering, Chapter 4.

B. UPRR will furnish all materials and will perform UPRR mainline construction work.

C. The Contractor shall provide all other materials required to perform the work as required to complete the Project.

2.2 CHEMICAL COMPOSITION

A. The chemical composition of the high strength rail shall be within the following limits per the current edition of AREMA Manual for Railway Engineering, Chapter 4, Part 2, Section 2.1.

1. Contractor shall furnish a complete report of the ladle analysis of each heat.

2. Contractor shall furnish drillings from the test samples for check analysis by an independent testing agency.

2.3 SURFACE HARDNESS PROPERTIES

A. Rail surface hardness shall be in accordance with the current edition of AREMA Manual for Railway Engineering Chapter 4, Part 2, Section 2.1.3.2. High strength rails shall be produced with a minimum hardness limit of Brinell 370.

B. A Brinell hardness test shall be performed in accordance with the current edition of AREMA Manual for Railway Engineering Chapter 4, Part 2, Section 2.1.3.2

2.4 MECHANICAL/TENSILE PROPERTIES

A. High Strength rail tensile properties shall be in accordance with the current edition of AREMA Manual for Railway Engineering Chapter 4, Part 2, Section 2.1.3.4.

2.5 ROLLING

A. The finished rail section shall be in accordance with the current edition of AREMA Manual for Railway Engineering 115RE rail section and subject to the following tolerances in accordance with Chapter 4, Part 2, Table 4-2-2.

2.6 BRANDING AND STAMPING

A. Branding and stamping shall be in accordance with Section 2.1.6 “Branding and Stamping” of the current edition of AREMA Manual for Railway Engineering.

2.7 TESTING FOR INTERIOR CONDITIONS

A. Rail shall meet the requirements of ASTM E428-05a. All rail shall be ultrasonically tested for internal imperfections in accordance with the current edition of AREMA Manual for Railway Engineering, Chapter 4, Part 2, Section 2.1.8.

2.8 CLASSIFICATION

A. Rail classification shall be in accordance with Section 2.1.10 “Surface Classification” of the current edition of AREMA Manual for Railway Engineering, Chapter 4.

2.9 STRAIGHTNESS

A. Rail straightness shall conform to the current edition of AREMA Manual for Railway Engineering Chapter 4, Part 2, Section 2.1.13.1.

2.10 FINISH

A. Rail ends shall be hot sawed, cold sawed or milled square at the ends. A variation of not more than $^{1}/_{32}$ inch in end squareness will be allowed. Rail end faces should be smooth and within $^{1}/_{32}$ inch to ensure proper surface contact for welding.

2.11 MARKINGS

A. Rail markings shall be in accordance with Section 2.1.15 “Markings” of the current edition of AREMA Manual for Railway Engineering, Chapter 4.

PART III - EXECUTION

3.1 RAIL STORAGE AND HANDLING

A. Layout Drawings: The Contractor shall submit layout drawings, lists and details of equipment for the storage and handling of rails and for the rail welding plant or plants the Contractor elects to use.

B. Handling and Storage

1. Equipment and methods to handle and store CWR strings shall conform to the requirements of AREMA Manual, Chapter 5, Section 5.1, Specification for Laying Rail and Chapter 5, Section 5.2.3, handling and transporting continuous welded rail.

2. Operations likely to cause scratching, notching, rubbing, scoring, or striking of the rails during any handling operations shall not be used.

3. CWR strings and individual unwelded rails shall be supported off the ground at spacings such that the load on the supporting ground will not exceed 1,500 pounds per square foot.

4. At the completion of the Contract, the Contractor shall hand the storage facilities over to others in a condition of maintenance and operation satisfactory to the Engineer.

C. At the completion of the Contract, rail designated as surplus by the Engineer shall be returned to UTA at the Contractor's expense. Rail shall be delivered to the UTA's storage site as designated by the Authority and unloaded in accordance with this Section and Special Provisions. Rail shall be in lengths no longer than 80 feet.

END OF SECTION

SECTION 34 12 35

CRT – CONCRETE TIES

PART I – GENERAL

1.1 SUMMARY

A. Description

1. This Section includes Specifications for the design, manufacture, fabrication, testing, inspection, furnishing, packaging, handling, loading, shipment, delivery, unloading and stockpiling of new prestressed pretensioned monoblock rubber padded and non-rubber padded concrete guardrail crossties, and concrete crossing crossties complete with rail fastener assemblies consisting of rail clips, shoulders, insulators and rail seat pads.

2. The Contractor shall furnish all labor, materials, equipment, facilities and transportation necessary to furnish and deliver the concrete ties to the project.

3. The Contractor shall furnish concrete ties as specified, per AREMA Manual for Railway Engineering, Chapter 30, “Ties”, Part 4 “Concrete Ties”, except as modified herein.

4. The Contractor shall furnish rubber padded concrete guardrail crossties for all bridge structures; padded ties are to be placed up to and on the abutment for structures.

5. The Contractor shall furnish concrete crossties for 115 RE running rail. These shall include concrete ties for guardrail (including convergent guardrail) and crossings.

6. The Contractor shall furnish miscellaneous rail fastener assembly hardware for the concrete crossties, as shown on the Contract Drawings.

B. Related requirements:

1. Section 34 12 37 - Concrete Grade Crossing Panels

2. Section 34 12 27 - Trackwork – Ballasted Track Construction

1.2 REFERENCES

A. The following Codes, Regulations, Reference Standards and Specifications apply to work included in this Section:

1. AREMA: American Railway Engineering Association

a. Current Edition of the American Railway Engineering Association, Manual for Railway Engineering

2. ASTM: American Society for Testing and Materials

a. Current Edition of the American Society for Testing and Materials, Standard

Specifications referenced herein

3. ACI: American Concrete Institute

    a. ACI 301: Specifications for Structural Concrete

1.3 SUBMITTALS

A. Submit the following for review and approval by the Engineer:

1. Separate submittals are required for all types of concrete ties.

2. Component Drawings for Rail fastening system (clip, shoulder, pad and insulator) description and product data. Submit within fifteen (15) days of Notice to Proceed.

3. Concrete tie shop drawings dimensioning/locating reinforcing steel, prestress tendons, lateral resistance patterns, and embedded items (rail fastener shoulders) submitted within fifteen (15) days of Notice to Proceed for:

    a. 8’-3” length concrete guardrail ties

    b. 8’-3” length rubber padded concrete guardrail ties

    c. 8’-3” length convergent guardrail ties

    d. 10’ length concrete crossing ties

4. Concrete tie prestress/flexural strength calculations. Submit within fifteen (15) days of Notice to Proceed.

5. Control Program and Test Plan. Submit within fifteen (15) days of Notice to Proceed.

6. Results of the tests identified in AREMA manual for Railway Engineering Chapter 30 “Ties”, Part 4 “Concrete Ties”, Section 4.9 “Testing of Monoblock Ties”. Submit no less than seven (7) days before delivery of the first shipment of concrete ties to UTA. Contractor may perform in-house testing upon approval of the UTA Project Manager. For tests the Contractor cannot perform in-house, the Contractor shall utilize an independent lab.

7. Monthly production quality reports. Submit reports for each month in which UTA ties are produced within fifteen (15) days after the last day of the month.

1.4 QUALITY ASSURANCE

A. The Contractor shall develop and maintain a Quality Control Program (QCP) regulating methods, procedures and processes to ensure compliance with standards of quality required by the Contract Documents for the duration of the Contract. The QCP shall include all tests and inspections specified herein. If any of the concrete ties are already in existence at the time of Notice to Proceed, the QCP shall address how the Contractor will document the quality of the existing material to UTA. The Contractor shall submit this program to the Engineer for review and approval.

B. The Contractor shall have primary responsibility for Quality Control and shall bear all expenses therefore. UTA reserves the right to perform additional testing and periodic inspection.

C. Within 30 days after the effective date of the Notice to Proceed, submit for approval of the Engineer a detailed narrative explaining the QCP procedures and organization to be utilized for the work. All work undertaken by the Contractor before approval of the QCP will be at the Contractor's risk. The Engineer will monitor the Contractor's methods, procedures and processes for compliance with the approved program.

D. Keep complete records of all testing and inspection work by the Contractor available to the Engineer and UTA during the performance of the Contract; and to such other agencies and for longer periods as may be specified elsewhere in the Contract.

1.5 ACCEPTANCE

A. Not applicable.

1.6 CONCRETE CROSSTIE DEFINITIONS

A. Flexure Strength: Resistance to bending.

B. Lateral Load: A load, or vector component of a load, at the gauge corner of the rail parallel to the longitudinal axis of the tie, and perpendicular to the rail.

C. Longitudinal Load: A load along the longitudinal axis of a rail.

D. Negative Bending: Bending of a concrete tie by application of a load that produces tension in the top surface of the tie.

E. Positive Bending: Bending of a concrete tie by application of a load that produces tension in the bottom surface of the tie.

F. Prestressing Tendon: A strand, wire, or bar, within a concrete member, which under tension, precompresses the concrete.

G. Prestressed Tie: A tie utilizing precompressed concrete and prestressing tendons to resist flexure.

H. Pretensioned Concrete Tie: A prestressed concrete tie using pretension tendons to precompress concrete.

I. Rail Fastener Assembly: A component or group of components consisting of embedded (in concrete tie) shoulders, resilient rail clips, insulators, and rail seat pads used to hold the rail to the concrete tie.

J. Rail Seat: The area of canted plane of a tie on which the running rail rests that lies within the confines of the rail base.

K. Rail Seat Pad: A pad located between the running rail and the rail seat of the tie.

L. Reinforcement or Reinforcing Steel: Steel, excluding prestressing tendons, introduced within a concrete tie to improve its structural strength and to control deflection and cracking.

M. Structural Crack: A crack originating in the tensile face of the tie, extending to the outermost level of reinforcement or prestressing tendons and which increases in size under application of increasing load.

N. Vertical Load: A load or vector component of a load, at right angles to a line joining the two rail seats of the tie and normal to the longitudinal axis of the rail.

O. Rubber padded concrete guardrail crossties (for structures); 1/2” conformal rubber interface pad placed and fixed under tie.

1.7 CONCRETE CROSSTIE DESIGN CRITERIA

A. Monoblock precast concrete ties shall be manufactured by using the pretensioned, prestressed long-line process using 18 each minimum 5.25 mm diameter steel prestressing tendons meeting ASTM A881 Grade 262 for the support of standard gauge continuous welded running rail in locations as shown on the plans. The concrete ties and rail fastener assemblies shall meet the design criteria and requirements specified herein.

B. Concrete ties shall be provided under this Contract for 115 RE running rail.

C. Concrete crossties shall be provided under this Contract.

1. Running rail fastening system (clip, shoulder, pad, and insulator), Pandrol USA “FAST CLIP” or approved equivalent, to support and transmit loads from the running rails into the concrete ties while electrically isolating the running rails from the concrete ties. The rail fastening system shoulder shall be embedded in the concrete tie, the rail fastening system clip shall be captured by the embedded shoulder, and the rail fastening system pad shall be attached to the concrete tie. The rail fastening system insulators shall be delivered in advance of or with their concrete ties, but will be installed by others after rail placement on the concrete ties.

D. Dimensions and Tolerances.

1. The basic configuration, dimensions and tolerances of the concrete guardrail crossties (with and without rubber padding) and concrete crossing crossties shall be:

a. The nominal tie dimensions shall be 8 3/16” tall x 10 3/8” wide at the bottom surface and 8’ 3” long for guardrail crossties. The nominal tie dimensions shall be 8 3/4” tall x 11“ wide at the bottom surface and 10’ long for crossing ties.

1) All ties shall have fasteners for running rail.

2) Guardrail ties shall have fasteners for guardrail in addition to running rail as shown in the Contract Drawings.

b. The rail seat shall provide for a cant of 1:40 toward the centerline of the precast concrete tie.

c. The rail seat shall be plane to a tolerance of +/- 1/32 inch for the portion

directly under the rail.

d. The differential tilt in the direction of the rail of one seat to another shall not exceed 1/16 inch.

e. For all ties the tie flexural strength shall be 318 inch-kips minimum railseat positive (RS+), 145 inch-kips railseat negative (RS-), 158 inch-kips minimum center positive (C+), and 177 inch-kips center negative (C-).

f. All ties shall incorporate a lateral resistance pattern on the side of the tie. The Engineer will review for approval the lateral resistance pattern, but will not provide the design of this pattern.

g. All rail ties shall be designed for and shall have rail fasteners for the support of two running rails.

h. Protrusions: Do not use sharp angles or protrusions which are easily damaged by handling or tamping.

i. Rail Seat Plane: Flat smooth surface within plus or minus 1/32 inch.

j. Differential Tilt of Rail Seats: The differential tilt in the direction parallel to the rail of one rail seat to the other rail seat shall not exceed 1/16 inch over a width of 6 inches.

k. Protrusion of Pretensioning Tendons: 1/8 inch maximum beyond the ends of the ties.

l. Concrete Cover for Prestressing Tendons, Ducts, and Prestressing End Fittings:

   1) Design dimension: 3/4-inch minimum cover. Measure cover from outside of embedded items to surface of concrete.

   2) Manufacturing tolerances for clear concrete protection (cover) and depth of prestressing tendons:

      i +1/8" for any two rows of tendons and

      ii +3/16" for the third row

m. Surface Finish

   1) The top and side surfaces shall present a smooth, uniform appearance. Except at the rail seat, a random scattering of surface voids will not be cause for rejection. Heavy concentrations of surface voids or evidence of improper mixing, vibrating, or curing will be cause for rejection.

   2) The bottom shall have a rough finish such as may be obtained with a broom.

n. Markings: Mark ties with indented or raised letters to indicate the manufacturer, day and year of manufacture, and tie type. A pour indicator button with the year and pour number is an acceptable alternative.

o. Rail Clip Toe Loads: The tolerances of the ties, shoulders, rail clips, insulators, and rail seat pads shall be small enough to prevent excessive variations in the rail clip toe loads. Tolerances which affect the rail clip toe loads shall be approved by the rail clip manufacturer and submitted to the Engineer for approval.

p. Rail Fastener Assembly

1) No portion of the rail fastener assembly shall project higher than 4 inches below top of rail when the rail is in its normal position.

2) No portion of the rail fastener assembly shall project more than 4-1/2 inches laterally from the rail when the rail is in its normal position.

E. Rail Fastener Assembly Components.

1. Rail fastener assemblies shall be designed for use with 115 RE rail.

2. Rail fastener assemblies shall be comprised of as few components as economically and technically feasible for ease of assembly, disassembly, and maintenance. The rail fastener assemblies shall include rail clips, rail seat pads, embedded shoulders and insulators. All rail fastener assembly components shall be furnished by the rail clip manufacturer.

3. The rail fastener assembly shall allow for the rail clips to be installed, loosened or removed in the field by one person using standard, readily available hand tools, but not be able to vibrate loose under operating conditions. The rail fastener assembly shall also allow for the rail clips to be installed, loosened or removed by commercially available, powered, automatic production track machinery.

4. Clip installation and removal shall not damage the crosstie, shoulder, clip, insulators or rail. The rail clip shall not notch nor otherwise damage the rail base during installation or removal.

5. The clips and fasteners shall be of threadless design.

6. Crossties shall have, on both sides of the rail base, a positive means of preventing more than 1/8 inch total lateral movement of the rail base relative to the fastener in case of failure or loosening of one or both rail clips. The positive means shall extend at least 3/8 inch above the base of rail in the installed position.

7. Recesses in the rail fastener assembly shall be free draining of water and debris in all values of track superelevation from zero inches to six inches. Fastener surfaces shall be resistant to conductive oil and dirt buildup and facilitate effective periodic cleaning by track maintenance equipment.

F. Rail Seat Pads.

1. Rail seat pads shall be used between the rail and the concrete crosstie to minimize abrasion of the rail seat area, reduce impacts and vibration effects on the track structure and provide electrical insulation of the rail.

2. The rail seat pads shall be compatible with the rail fastener system with a shape, which provides a positive means of preventing movement of the pad parallel to the rail. Rail seat pads shall have a thickness of at least 3/16 inch and not more than 7/16 inch, a width to extend around the shoulder to lock it in place and a length one inch longer than the rail seat bearing area. Pads shall be marked in a permanent manner to indicate manufacturer, material, month and year manufactured, and designation.

3. Rail seat pads shall be manufactured from natural rubber which provides the required chemical and physical properties to resist effects of temperature ranging from -200 F to +1600 F, as well as oxidation, water, alkali, salt, petroleum products, synthetic lubricants, and sunlight. First quality, new ingredients, processed and cured in accordance with accepted good practice shall be used. Oil-extended rubber, reclaimed rubber, or rubber containing wax shall not be used.

G. Rail Clips.

1. The rail clip shall be a threadless, detachable, one-piece elastic, heat treated, alloy spring steel clip. One identical clip shall be used on the field and gauge side of the rail at the rail seat.

2. The clips shall be reusable after removal through repeated applications without any effect on the operating performance of the system.

3. No part of the clip shall protrude below the tie surface or into the tie.

4. The rail clip shall not have direct point contact with the rail. The clip shall be such that lateral rail movements within the confines of the shoulders will not produce transverse denting, carving, or scoring of the rail base. The clip shall be such that longitudinal rail slippage will not produce overstressing, bending, twisting, or other damage to the clips, and will not damage the rail.

5. Spring-wedge clips shall not be permitted.

6. Rail clips and insulators used on rail joint bars need not be identical in design to those used on standard rail, but they shall have similar performance characteristics, shall be made by the same manufacturer, and shall be installed into identical shoulders as the standard rail clip.

H. Insulators.

1. Insulators shall be used between the rail clip, the embedded shoulder and the rail, providing electrical isolation, reducing abrasion, and transferring dynamic loading from the rail to the rail clip to prevent relative motion in any direction.

2. There shall be a minimum of two insulators for each rail fastener assembly, one on each side of each rail. Insulator configurations utilizing clip insulators or toe and side post insulators are acceptable. Insulators shall insulate the rail clip from direct contact with the rail, and also insulate the rail from the shoulder inserts.

3. Except for surfaces in contact with the rail, the surfaces of the insulators shall be smooth, clearly finished and free of flash. Insulators shall be free of internal

defects and cavities.

4. Insulators shall be made of materials, which provide the required, electrical, chemical and physical properties to resist dynamic loading, oxidation, water, alkali, salt, petroleum products, synthetic lubricants, and sunlight through a temperature range of -200 F and +1600 F.

5. Keys shall be provided between the insulators and the fastener hardware to prevent relative motion in any direction.

6. The insulators shall cover the full widths of the shoulders.

I. Embedded Shoulders.

1. Embedded shoulders shall be threadless, designed to provide and maintain proper position and alignment of the rail, rail clip, insulators, rail seat pad, and running rail base.

2. The shoulder shall not be directly anchored to the pretensioned steel.

3. The shoulder shall be ragged stem design, or other design as approved by the Engineer, to maximize the surface area and pull-out resistance.

PART II - PRODUCTS

2.1 CONCRETE

A. Compressive Strength

1. Minimum 28-Day Design Compressive Strength: 7000 psi.

2. Samples for compressive strength testing shall be obtained in accordance with ASTM C 172. Specimens shall be made and laboratory cured in accordance with ASTM C 31. Specimens made to check the adequacy of curing and protection of concrete shall be cured entirely under production conditions. Concrete temperature shall be recorded during curing.

3. Strength tests shall be performed on 6 inch by 12 inch cylinders in accordance with ASTM C 39. For each day of production, at least six cylinders shall be prepared and capped in accordance with ASTM C 617: two for 28-day strength tests, two for checking strength at prestress transfer and two for spares.

4. Minimum transfer requirement is f'c = 4,500 psi for wire and strand.

B. Flexural Strength

1. Minimum 28-Day Flexural Strength: 750 psi.

2. Samples from which flexural strength test specimens are molded shall be obtained in accordance with ASTM C 31. Specimens to check the adequacy of curing and protection of concrete shall be cured entirely under production conditions.

3. Strength tests shall be made on 6 inch by 6 inch by 20 inch beams in accordance

with ASTM C 78. One beam shall be tested for every 2,000 ties produced.

C. Concrete Mix Design

1. The concrete mix design shall be qualified based on tests on trial batches which show that the concrete mix achieves the specified strengths and properties.

2. The mix design submittal shall include at least the following data to demonstrate conformance with the specified requirements:

   a. Qualification testing of all concrete components, including admixtures.

   b. Proportions of all concrete components.

   c. Concrete strength, shrinkage and permeability results.

3. A new mix design shall be submitted to qualify the mix if any constituents of the concrete are changed during crosstie production.

4. If heat curing of concrete is used, the forms may be preheated to avoid cooling of concrete after placing, but the temperature of the concrete shall not rise above 104 degrees F until initial set (ASTM 403) has occurred, nor shall any heat be applied between casting and initial set.

5. The rate of temperature rise in the concrete shall not exceed 36 degrees F per hour and the maximum concrete temperature shall not exceed 158 degrees F. the heating method shall be such that all ties in a bed are at similar temperature.

D. Cement

1. Cement shall conform with ASTM C 150, Type II or III low alkali (less than 0.60% alkali content). The false set penetration, when tested in accordance with ASTM C 359, shall not be less than 50 mm initially, 35 mm at intermediate times, and 40 mm after remix. Tests shall be conducted at 3, 5, 8, 11 minutes and after remix.

2. Separate random samples of cement shall be taken each day of production to represent the cement used on each bed. Each sample shall not be less than one pound and shall be clearly identified with the date and bed number. Each sample shall be kept in airtight containers until the corresponding 28 day cylinder tests have been carried out and results accepted by the Engineer.

3. Not more than two sources of clinker or ground cement shall be used by the manufacturer during any one month. Cement from each source shall be clearly identified and stored in separate weather tight silos. If two sources of cement are used on one bed, the tests shall be performed on the first batch of concrete made with each cement and thereafter as required. Strength tests shall also be conducted on concrete made with each type of cement.

4. Cement mill certificates shall be provided weekly by each supplier and shall contain the results of the following tests on cement delivered during that week.

   a. Fineness by Air Permeability (ASTM C 204).

b. False Set (ASTM C 359) - Penetration at 3, 5, 8, 11 minutes and after remix.

c. Setting Time (ASTM C 191).

d. Compressive Strength (ASTM C 109) at 1 day, 3 days, and 7 days.

e. Chemical Analysis (ASTM C 114) - Including SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, SO_3, K_2O, Na_2O, and calculated alkalies as Na_2O equivalent, C_3S, C_2S, C_3A, C_3AF.

f. Residue on 325 mesh sieve (ASTM C 430).

5. At least once during every three months, a randomly chosen sample of cement from each source used shall be analyzed for alkali content in accordance with ASTM C 114 by an outside testing laboratory.

E. Fine and Coarse Aggregates: AREMA Specifications for Aggregates, Article 1.3, Chapter 8 of the AREMA Manual, except as modified herein. Coarse aggregates shall be gravel, crushed gravel, crushed stone, or a combination thereof.

1. Aggregates shall be natural aggregates complying with ASTM C 33 Class 4S.

2. The manufacturer shall provide evidence that concrete containing aggregate from the proposed source with a cement content and alkali burden similar to the job mix, has a satisfactory service history of at least 5 years. This evidence shall include structures requiring a Class 4S aggregate.

3. The maximum size of aggregate shall be 1 inch. If the coarse or fine aggregate is supplied in more than one size, each size shall be stored separately.

4. Washed aggregate shall be allowed to drain, in stockpiles, before use. All aggregates shall be free from ice when used.

5. In addition to the requirements of ASTM C 33, the following tests shall be conducted by an outside testing laboratory.

a. Petrographic examination to ASTM C 295: This shall be conducted on each new source.

b. Evaluation of potential alkali reactivity to ASTM P 214:

1) A separate test shall be conducted with each job cement and the results shall conform with ASTM C 33 at three and six months.

2) This shall be repeated every 6 months for each source.

3) Failure criterion shall be modified to be 0.08% expansion at 14 days. A constant water/cement ratio of 0.50 by mass shall be used.

c. Evaluation of potential alkali carbonate reactivity: Aggregates containing carbonate shall be tested in accordance with ASTM C 586 and C 1105.

F. Water

1. Water content shall be kept to a minimum consistent with the strength requirements and placement needs.

2. Water for mixing concrete shall be potable and free from harmful amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or steel.

3. Mixing water, including that portion of the mixing water contributed in the form of free moisture on aggregates, shall have a chloride ion content of less than 100 ppm.

4. When required, mixing water shall be tested in accordance with AASHTO T 26.

G. Concrete Admixtures

1. Concrete admixtures may be included in the concrete mix to improve the water-cement ratio or workability of the concrete, providing the strengths specified and other desirable characteristics of the concrete can be achieved and maintained. Admixtures require approval of the Engineer before they may be used.

2. If used, concrete admixtures shall conform to the following requirements:

a. Air-Entraining Admixtures: ASTM C 260.

b. Accelerating, Retarding, and Water-Reducing Agents: ASTM C 494.

c. Other Pozzolanic Admixtures: ASTM C 618.

3. Admixtures containing chlorides, fluorides, sulphites, nitrates, or aluminum powder shall not be used.

H. Cement Content: 600 pounds per cubic yard, minimum.

I. Water-Cement Ratio: 0.45 maximum.

J. Entrained Air: Total air content 3% to 5% in hardened concrete.

2.2 PRESTRESSING TENDONS

A. Prestressing tendons shall be pretensioned.

B. Prestressing tendons shall be one of the following types:

1. Wire for tendons in prestressed concrete per ASTM A 864/A 864M or A 881/A 881M.

2. Strand for tendons in prestressed concrete per ASTM A 416, A 886/A 886M or equal. Strands larger than 7/16-inch diameter shall not be used.

2.3 RAIL CLIPS

A. Rail clips shall be forged from alloy steel and quenched to achieve the specified holding power.

B. Prior to its use in the rail fastener assembly, the spring clip shall be approved by the spring clip manufacturer for application in the rail fastener system of the proposed concrete tie. Written certification of such approval shall be submitted to the Engineer.

2.4 INSULATORS

A. Insulator material shall be injection molded nylon conforming to ASTM D 789, Type 1, Grade 2, ultra-violet stabilized, or approved equal.

B. Insulators shall be protected against oxidative embrittlement by inclusion of a non-conductive ultraviolet stabilizer, which will not diminish the electrical insulation properties of the insulators.

C. Recycled material shall not be used.

2.5 EMBEDDED SHOULDERS

A. Ductile cast iron conforming to ASTM A 536 Grade 60-40-18, or 65-45-12.

2.6 RAIL SEAT PADS

A. Rail seat pads shall be manufactured from natural rubber.

PART III – EXECUTION

3.1 RAIL SEAT PADS QUALIFICATION TESTING REQUIREMENTS

A. Specimens: Perform the following tests on each of two specimens. The specimens shall be manufactured and cured in the same manner as the final product. Use a separate pair of specimens for each test, except the accelerated aging test. Prior to testing, condition all specimens for at least 7 days at 230 C and 50% relative humidity. Failure of either of the two specimens to meet requirements shall be cause for rejection.

B. Hardness: Measure the hardness in accordance with ASTM D2240. The reading on each panel shall be between 70 and 90 durometers, Shore A. Average the two reading and record the average for reference in production testing.

C. Tensile Strength, measured by ASTM D 412: 1,500 psi, minimum.

D. Ultimate Elongation, measured by ASTM D 412: 250 percent, minimum.

E. High Temperature Compression Set: Using Method B of ASTM D 395, test for 22 hours at 1000 C. The compression set shall not exceed 40 percent.

F. Compression Set at Minus 180 C: Using ASTM D 1229, test for 22 hours at minus 180 C. The compression set at 30 minutes after release (t30 reading) shall not exceed 25%.

G. Accelerated Aging: Using ASTM D 573, age the elastomer for 8 hours at 1000 C. Measure and record the change in hardness, tensile strength, and ultimate elongation. The tensile strength shall not decrease more than 15%. The ultimate elongation after aging shall be at least 200% and shall be at least 60% of the result before aging. The change in hardness measured on the durometer A scale shall not

exceed 10 points.

H. Resistance to Ozone Cracking: Prepare test specimens in accordance with Procedure A of ASTM D 518. Test the specimens in accordance with ASTM D 1149 at a temperature of 40 degrees C and an ozone concentration of 50 pphm. The elastomer shall not exhibit any cracking when examined in accordance with ASTM D 1149 at the end of a 100 hour exposure.

I. Oil Absorption: Using ASTM D 471, conduct one test with ASTM No. 3 oil at 1000 C for 70 hours and conduct another test using a different sample with ASTM No. 1 oil at 1000 C for 70 hours to determine the volume change for the elastomer. For No. 1 oil, the volume change shall not exceed minus 10% or plus 20 %. For No. 3 oil, the volume change shall not exceed 100%.

J. Volume Resistivity: Apply 100 volts dc for three minutes. The volume resistivity, measured in accordance with ASTM D257, shall be 1 x 1012 ohm-cm, minimum.

K. Water Absorption: Using ASTM D 471, test for 70 hours at 1000 C in distilled water. The volume change shall not exceed plus 35% or minus 0%.

3.2 INSULATORS QUALIFICATION TESTING REQUIREMENTS

A. Specimens: Perform the following tests on each of two specimens. The specimens shall be manufactured and cured in the same manner as the final product. Use a separate pair of specimens for each test. Failure of either of the two specimens to meet requirements shall be cause for rejection.

B. Volume Resistivity: 1012 ohm-cm, minimum. Measure in accordance with ASTM D 257.

C. Water Absorption at Saturation: 5.5%, maximum. Measure in accordance with ASTM D 570.

D. Hardness: Minimum 78, maximum 82, Shore D, when measured in accordance with ASTM D2240.

E. Dry Shear Strength: 650 psi, minimum. Measure in accordance with ASTM D 732.

F. Deformation under Load: Five percent, maximum. Measure at 2000 psi and 500 C in accordance with ASTM D 621.

G. Deflection Temperature: 2200 C, minimum. Measure in accordance with ASTM D 648.

H. Weathermometer test: After 1000 hours with cycled water spray, the yield stress shall be a minimum of 8000 psi and the tensile strength shall be a minimum of 6000 psi.

3.3 CONCRETE TIE AND RAIL FASTENER ASSEMBLY QUALIFICATION AND TESTING REQUIREMENTS

A. Following review and approval of the Shop Drawings by the Engineer, with the rail seat pads and insulators having successfully completed qualification testing and

certification, a lot of at least ten concrete ties conforming to the Shop Drawings and these Specifications shall be produced. The Engineer will select four of these ties for laboratory testing. For design testing of rail fastener assemblies, the Contractor shall furnish a complete concrete crosstie, a section of a crosstie or an equivalent prestressed concrete block with rail seat and rail fastener assembly identical to the crossties furnished for testing.

B. The tie block and each of the four ties submitted for testing will be carefully measured and examined to determine their compliance with the specified dimensions and tolerances. Upon satisfactory completion of this examination, the tie block; and the two ties, which shall be known and identified as Ties A and B respectively; shall be subjected to the qualification testing program specified herein. The remaining two ties, which shall be known and identified as Ties C and D, will be retained by the Engineer for further test use and as a control for dimensional tolerances and surface appearance of ties subsequently manufactured. Approval of the concrete crosstie design and the rail fastener assembly design is dependent upon the successful completion of the specified qualification testing program.

C. The Contractor shall perform the tests and inspections.

D. Sequence of Qualification Tests;

1. Rail Seat Positive and Negative Vertical Load Tests, described in Article 3.04.A. Perform on one rail seat of Tie A, hereinafter designated Rail Seat A-1.

2. Center Negative Bending Moment Test, described in Article 3.04.B.

3. Center Positive Bending Moment Test, described in Article 3.04.C.

4. Rail Seat Positive and Negative Vertical Load Tests, described in Article 3.04.A. Perform on the other rail seat, hereinafter designated Rail Seat A-2.

5. Rail Seat Repeated Load Test, described in Article 3.06.A. Perform on Rail Seat A-2.

6. Bond Development and Ultimate Load Test, described in Article 3.04.D. Perform on Rail Seat A-1.

E. Sequence of Qualification Tests; Tie B

1. Shoulder Tests, described in Article 3.04.E. Perform on all shoulders.

2. Fastener Uplift Test, described in Article 3.04.F. Perform on one rail seat.

3. Electrical Tests, described in Article 3.05.

F. Sequence of Qualification Tests; Tie Block

1. Spring Rate Test, described in Article 3.06.C. Conduct the test on three rail seat pads. The two pads providing the highest and lowest spring rate values shall be used for tests 2 through 8, following.

2. Fastener Uplift Test, Part 1, described in Article 3.04.F.

3. Fastener Longitudinal Restraint Test, described in Article 3.04.G.

4. Fastener Repeated Load Test, described in Article 3.06.B.

5. Fastener Longitudinal Restraint Test, described in Article 3.04.G.

6. Fastener Uplift Test, Part 2, described in Article 3.04.F.

7. Lateral Load Restraint Test, described in Article 3.04.H.

8. Spring Rate Test, described in Article 3.06.C.

G. The Contractor shall submit the qualification test results to the Engineer for review and approval prior to commencing production. The Contractor shall not begin manufacturing the crossties nor the rail fastener assemblies until the Engineer has approved the qualification test results and has authorized production.

3.4 CONCRETE TIE AND RAIL FASTENER ASSEMBLY STATIC TESTS

A. Rail Seat Positive and Negative Vertical Load Tests: With the tie supported and loaded a load increasing at a rate of not greater than five kips per minute shall be applied until a load P of 51 kips is obtained. This load shall be held for at least three minutes; during which time, an inspection shall be made to determine if structural cracking occurs. An illuminated 5-power magnifying glass shall be used to locate cracks. In like manner, the tie shall be supported and loaded until a load of P of 29 kips is obtained. If structural cracking does not occur, the requirements of each portion of this test will have been met.

B. Center Negative Bending Moment Test: With the tie supported and loaded a load increasing at a rate not greater than five kips per minute shall be applied until a load P of 15 kips is obtained. This load shall be applied for at least three minutes; during which time, an inspection shall be made to determine if structural cracking occurs. An illuminated 5-power magnifying glass shall be used to locate cracks. If structural cracking does not occur, the requirements of this test will have been met.

C. Center Positive Bending Moment Test: With the tie supported and loaded a load increasing at a rate not greater than five kips per minute shall be applied until a load P of 10 kips is obtained. This load shall be held for at least three minutes; during which time, an inspection shall be made to determine if structural cracking occurs. An illuminated 5-power magnifying glass shall be used to locate cracks. If structural cracking does not occur, the requirements of this test will have been met.

D. Bond Development and Ultimate Load Test: With the tie supported and loaded at Rail Seat A-1 a load increasing at a rate not greater than five kips per minute shall be applied until a load of 76 kips is obtained. If there is no more than 0.001 inches strand slippage determined by an extensometer reading to 1/10,000 inch, suitably attached to the end of the tie, the requirements of this test will have been met. The measurement shall be made on the outermost tendons of the lower layer. The load shall then be increased until ultimate failure of the tie occurs, and the maximum load obtained shall be recorded.

E. be increased until ultimate failure of the tie occurs, and the maximum load obtained shall be recorded.

F. Shoulder Tests

1. Pull-out Test: The Pull-out Test shall be performed on each shoulder, an axial load of 12 kips shall be applied to each shoulder separately and held for at least three minutes; during which time, an inspection will be made to determine if there is any slippage of the shoulder or any cracking of the concrete. The shoulder shall not slip and there shall be no cracks wider than 0.003 inch. Inability of the shoulder itself to resist the 12 kip load without permanent deformation shall also constitute failure of this test. Separation of laitance surrounding the shoulder will not be cause for rejection.

2. Torque Test: Following successful completion of the Pull-out Test, the Torque Test shall be performed on each shoulder. A torque of 250 foot-pounds shall be applied about the vertical axis of the shoulder by means of a calibrated torque wrench and a suitable attachment to the shoulder. The torque shall be held for at least three minutes. Ability of the shoulder to resist this torque without rotation, cracking of the concrete, or permanent deformation shall constitute passage of this test.

G. Fastener Uplift Test

1. An 18 to 20 inch piece of 115 RE rail shall be secured to one rail seat using a complete rail fastener assembly, including tie pads, rail clips, and insulators. An incremental load shall be applied to the rail until the rail separates from the pad, the pad separates from the rail seat or a load P of 10 kips is reached, whichever occurs first. The load P (measured load plus the unsupported tie weight plus the frame weight) at which the rail separates from the pad, the pad separates from the rail seat, or 10 kips is reached, whichever occurs first, shall be recorded.

2. The load shall then be completely released. A load of 1.5 P or 10 kips, not to exceed 10 kips then be applied. The shoulders shall not pull out or loosen in the concrete and no component of the fastener assembly shall fracture nor shall the rail be released.

H. Fastener Longitudinal Restraint Test

1. Both before and after the performance of the Fastener Repeated Load Test above, and without disturbing the rail fastener, the tie and rail fastener system shall be subjected to a Longitudinal Restraint Test. A longitudinal load shall be applied in increments of 400 pounds with readings taken of longitudinal rail displacement after each increment. Readings of rail displacement shall be the average of the readings of two dial indicators reading to 0.001 inch, one placed on each side of the rail with their plungers parallel to the longitudinal axis of the rail. The load shall be applied in the direction coinciding with the longitudinal axis of the rail. The load shall be incrementally loaded until a load of 2400 pounds is reached. This load shall be held for at least 15 minutes. The rail shall not move more than 0.200 inch during the initial ten-minute period and shall not move more than 0.005 inch during the second 3 minutes. The fastener shall be capable of meeting the requirements of this test in either direction. If these criteria are met, the tie and fasteners will have passed this test.

I. Lateral Load Restraint Test

1. With a suitable length of new 115 RE rail affixed to the tie block in a manner appropriate to the fastener being tested, the entire assembly shall be supported and loaded. The loading head shall be fixed against translation and rotation. The wood block shall be 10 inches by 10 inches by 3/4 inch thick, five ply, exterior grade plywood.

2. A preload of 20 kips shall be applied to the rail to seat the rail in the fastener. Upon release of the preload, a zero reading shall be taken on the dial indicators, which measure rail translation. Load is to be applied at a rate not to exceed five kips per minute until either 41 kips have been applied or the rail base has translated1/8 inch, whichever occurs first. Inability of the fastener to carry the 41 kip load with1/8 inch or less of rail translation shall constitute failure of this test. Complete Failure of any component of the tie or fastener is cause for rejection.

J. With all load removed from the rail, a roller nest shall be placed between the fixed loading head and the wood block on the rail head. The roller nest shall not offer resistance to lateral movement of the rail head. After taking zero readings on the dial indicators, which measure gauge widening and rail translation, a load of 20.5 kips shall be applied at a rate not to exceed five kips per minute. Rail rotation, gauge widening less rail translation, greater than 1/4 inch shall constitute failure of this test.

3.5 ELECTRICAL TESTS

A. Two short pieces of 115 RE rail shall be affixed to a tie using tie pads, insulators and fasteners. The rail pieces shall be longer than the width of the tie. Contact points shall be cleaned on each rail and cables shall be attached to the rail. A contact point shall be cleaned on a prestressing tendon near the middle of one end of the tie and a cable (hereinafter designated as ground) a cable attached. 500 volts dc shall be applied from each running rail to ground for three minutes each. The resistance shall be measured fromeach running rail to ground with an accuracy of plus or minus two percent. After obtaining the readings, the electrical connections shall be removed.

B. each running rail to ground with an accuracy of plus or minus two percent. After obtaining the readings, the electrical connections shall be removed.

C. The complete assembly shall be immersed in water for six hours at room temperature.

D. Within 60 minutes after removal from the water, without drying, the fastener assembly shall be tested for electrical impedance. A potential of 50 volts ac shall be applied from each running rail to ground for one minute for each rail for each increment of measurement for frequencies from 20 hertz to 12 kilohertz in increments of 20 hertz up to 100 hertz, 200 hertz up to 1,000 hertz, and 2,000 hertz up to 12 kilohertz. The impedance after one minute shall be measured with an accuracy of plus or minus two percent and recorded for each frequency.

E. Within two hours after removal from the water, without drying, the fastener assembly shall be tested for electrical resistance. 500 volts dc shall be applied from each running rail to ground for three minutes each. The resistance from each running rail to ground shall be measured with an accuracy of plus or minus two percent.

F. The minimum resistance for 500 volts dc shall be 10 megaohms when dry and 0.4 megaohms when wet. The minimum impedance for any frequency between 20 hertz

and 12 kilohertz with 50 volts shall be 10,000 ohms.

3.6 DYNAMIC TESTS

A. Rail Seat Repeated Load Test: Following the Rail Seat Positive and Negative Vertical Load Tests on Rail Seats A-2 or B-2, the load shall be increased at a rate of at least five kips per minute until the tie is cracked from its bottom surface up to the level of the lower layer of reinforcement. After removal of the static rail seat load necessary to produce cracking, and substitution of 3 inch thick plywood strips for the rubber supports the tie shall be subjected to three million cycles of repeated loading with each cycle varying uniformly from 4 kips to 56 kips. The repeated loading shall not exceed 600 cycles per minute. If, after the application of three million cycles, the tie can support the rail seat load of 56 kips, the requirements of this test will have been met.

B. Fastener Repeated Load Test

1. An 18 to 20 inch section of new 115 RE rail from which the loose mill scale has been removed by wiping with a cloth shall be secured to the rail seat in the tie block using a complete rail fastener assembly. Determine the load P that will just cause separation of the rail from the rail seat pad or the pad from the rail, whichever occurs first. This load may be determined during the Fastener Uplift Test described in Article 3.04.F, in which case a new set of rail clips shall be used for the Repeated Load Test.

2. An 18 to 20 inch section of new 115 RE rail from which the loose mill scale has been removed by wiping with a cloth shall be secured to the rail seat in the tie block using a complete rail fastener assembly. Alternating downward and upward loads shall be applied at an angle of 200 to the vertical axis of the rail at a rate not to exceed 300 cycles per minute for three million cycles. The rail shall be free to rotate under the applied loads. One cycle shall consist of both a downward and an upward load. The magnitude of the upward load shall be 0.6 P where P is the load determined in Article 3.06.B.1. If springs are used to generate the upward load, the downward load shall be 30 kips plus 0.6 P. If a double-acting hydraulic ram is used to generate both the upward and downward load, the downward load shall be 30 kips.

3. ad, the downward load shall be 30 kips.

4. This test may generate heat in elastomeric rail seat pads. Heat build-up in such pads must not be allowed to exceed 1400 F. Heat build-up can be controlled by reducing the rate of load application or by providing periods of rest to allow cooling of the pad to take place.

5. Rupture failure of any component of the fastener shall constitute failure of this test.

C. Spring Rate Test

1. The rail seat pad shall be loaded vertically using a rail section secured to the tie block by a complete rail fastener assembly.

2. A cyclic load varying from 4 to 30 kips shall be applied continuously at a rate of

four to six cycles per second for a total of 1,000 cycles.

3. A static load shall be applied, at a rate between 3 and 6 kips per minute, in increments of 1 kip up to a maximum of 51 kips. For each load increment, the vertical pad deflection shall be measured to the nearest 0.0001 inch at each of four symmetrically placed dial indicators and recorded. The recorded values for vertical load versus deflection shall be plotted on a graph. The spring rate, as determined by the slope of the line connecting the points representing pad deflections at 24 and 44 kips shall be calculated.

4. The load shall be released and the pad deflection recorded 10 seconds after load removal.

5. All of the following requirements shall be met:

    a. Each pad shall return to within 0.002 inch of its original position 10 seconds after load removal.

    b. The final spring rate value for each pad when determined per Article 3.03.F.8 shall not vary more than 25 percent from the initial value for that pad determined per Article 3.01.F.

    c. The spring rate values determined from initial tests conducted on three pads as specified in Article 3.03.F.1 shall not vary more than 25 percent from each other.

    d. The spring rate values determined from final tests conducted on two pads as specified in Article 3.03.F.8 shall not vary more than 25 percent from each other.

3.7 CONCRETE TIE AND RAIL FASTENER ASSEMBLY PRODUCTION TESTING REQUIREMENTS

A. During concrete crosstie production the Contractor shall perform all tests and inspections specified herein to ensure compliance with these Specifications and the approved concrete tie design.

B. The Contractor shall perform the tests and inspections.

C. Daily Production Tests

1. One crosstie selected at random from each lot of 200 ties of the same design or fraction thereof produced each day shall be subjected to the following tests and inspections prior to delivery. Each tie shall be tested with different rail clips, insulators, and rail seat pads. All fastener parts tested shall be individually selected at random and shall be selected from each production lot in proportion to the number of parts in that lot.

    a. The rail seat configuration and shoulder location shall be verified by use of a template for compliance with the approved Shop Drawings.

    b. The positive moment portion of the Rail Seat Positive and Negative Vertical Load Test specified in Article 3.04.A shall be performed on the tie. The load

shall be applied at a rate of at least five kips per minute and held it for at least one minute.

c. An electrical test shall be performed to check for shoulder to shoulder direct electrical shorts at 10 volts dc using an ohm meter. The resistance shall not be less than 100 ohms.

2. All ties in the lot will be accepted if the test tie passes the above tests and inspections. If the test tie fails any of the tests and inspections, two additional ties from the same lot shall be tested and inspected. If both of these ties meet the test and inspection requirements, the lot will be accepted. If either of these ties fails to meet the test and inspection requirements, 100% of the remainder of the ties in the lot shall be tested and inspected or rejected.

D. Bond Development Test

1. One tie selected at random from every five long line bed of ties of the same tie design, or fraction thereof, produced, and accepted on the basis of meeting the test and inspection requirements of Article 3.07.C shall be subjected to the Bond Development Test specified in Article 3.04.D. A load rate exceeding five kips per minute may be applied.

2. All ties in the lot will be accepted if the test tie passes the test. If the tie does not pass the test, three additional ties shall be selected at random and tested. If all three ties meet the test requirements of Article 3.04.D, the lot will be accepted. If any of the three additional ties does not meet the requirements of Article 3.04.D, 100% of the remainder of the ties in the lot shall be tested or rejected.

E. Disposition of Test Ties: Ties that pass the testing requirements, have no cracks or only non-structural cracks, and are otherwise undamaged after testing, will be considered acceptable for delivery.

F. The Contractor shall perform the slump tests, cylinder compression tests, air entrainment tests, and other material tests specified herein in accordance with the specified ASTM. Tests shall be required at a minimum of every 25 cubic yards of concrete and shall be verified by a registered professional engineer.

G. During production, the Contractor shall submit to the Engineer the certified results of the production tests and inspections. Upon submittal of the production test and inspection results, and certification requirements for each lot, that lot will be released by the Engineer for shipment from the Contractor’s facility.

3.8 RAIL SEAT PADS PRODUCTION TESTING REQUIREMENTS

A. During rail seat pad production the Contractor shall perform all tests and inspections specified herein to ensure compliance with these Specifications.

B. The Contractor shall perform the tests and inspections.

C. Batch Control: A batch is defined as the rubber mixed, processed and cured together, not exceeding one day's production. The rail seat pads shall be kept segregated by batch.

D. Daily Production Tests

1. Two samples chosen at random from each batch shall be tested for hardness each day. Prior to testing, each sample shall be conditioned for at least 7 days at 230 C and 50% relative humidity.

2. When measured in accordance with ASTM D 2240, the hardness shall be within plus or minus five durometers, Shore A, of the average recorded in Article 3.01.B.

3. If either of the two samples fails the test, the entire batch shall be rejected.

E. Weekly Production Tests

1. Two samples chosen at random from a batch shall be tested for tensile strength, ultimate elongation, high temperature compression set, volume resistivity and water absorption each week. Two different samples shall be used for each test. Prior to testing, each sample shall be conditioned for at least 7 days at 230 C and 50% relative humidity.

2. Tensile strength, ultimate elongation, high temperature compression set, volume resistivity and water absorption tests shall be performed as specified in Article 3.01.

3. If any sample fails a test, the entire batch shall be rejected.

F. During production, the Contractor shall submit to the Engineer the certified results of the production tests and inspections. Upon submittal of the production test and inspection results, and certification requirements for each lot, that lot will be released by the Engineer for shipment from the Contractor's facility.

3.9 QUALIFICATIONS OF CONCRETE CROSSTIE FABRICATOR

A. Concrete crossties shall be produced in a plant or production facility by a fabricator who has regularly and continuously engaged in the manufacture of precast, prestressed concrete products for a minimum of 5 years. In addition, the fabricator shall have had experience in the fabrication of precast, prestressed concrete ties similar to the ties indicated.

B. Fabricator shall have sufficient production capacity to produce the required number of ties in accordance with the quality requirements and without causing any delay in the Work.

C. The fabricator shall furnish certification that all aspects of the yard operation, including materials testing, storage and handling conform to the quality control requirements herein, and current industry standards as defined in the PCI Manual for Quality Control of Plants and Production of Prestressed, Precast Concrete Products, MNL 116 and ISO 9001:2000 equivalent.

D. Current certification by PCI throughout the fabrication period will be accepted as evidence of conformance with this requirement.

E. Certification by a qualified, independent consultant or testing laboratory will also be

accepted as evidence of conformance with this requirement. Initial certification shall be based on a plant inspection of yard operations and quality control procedures. The Engineer shall be notified prior to the inspection and may attend. At least two follow-up inspections shall be performed during the production run and each certification of conformance submitted to the Engineer.

3.10 PRODUCTION

A. Fabricate concrete crossties and fastener components to sizes, configurations and dimensions shown on approved Shop Drawings, using manufacturer's standard methods and quality control procedures.

B. Prestressing Tendons

1. Placement and Spacing: Place and space prestressing steel in accordance with the AREMA Manual for Railway Engineering, Chapter 10 - Concrete Ties, Article 1.3 - Tie Dimensions, Configuration and Weight.

2. Supports: Accurately place and support prestressing steel before concrete is placed. Secure the prestressing steel against displacement greater than the permitted tolerances.

3. Prestressing Steel: Inspect for proper surface condition. Prestressing steel contaminated with form release agents or other substances, which would reduce bond, shall be cleaned.

C. Concrete Curing: Cure in accordance with the AREMA Manual for Railway Engineering, Chapter 10 - Concrete Ties, Article 1.2 - Material, Article 1.2.2.5 - Curing, except as modified herein.

3.11 SHOP INSPECTION BY THE ENGINEER

A. The Engineer reserves the right to inspect all products at the Contractor's facilities during manufacturing or testing, and prior to shipment. Materials shall not be prepared for shipment before the Engineer has either inspected the materials or waived inspection. Any deficiencies found shall be corrected prior to shipment. Any inspection or waiver of inspection shall in no way relieve the Contractor of the responsibility of furnishing materials in accordance with these Specifications.

B. All material furnished under this Contract shall be presented for inspection at the place of manufacture. The Contractor shall provide the Engineer free entry at all times to the manufacturer’s plant to inspect the manufacture of the concrete crossties and rail fastener assemblies while Work on this Contract is being performed.

C. The Contractor shall afford the Engineer, at no additional cost to UTA, all labor, material, tools, measuring instruments, testing equipment and other equipment necessary to examine the Work during its progress, as well as the finished product, to satisfy her/him that the materials comply with the Specifications.

D. All material for inspection shall be presented in a safe area away from excessive noise and manufacturing activities. The Contractor, at no additional cost to UTA, shall provide all labor, material, tools and equipment required to facilitate inspection

of the top, bottom and sides of the crossties.

E. The Contractor, at no additional cost to UTA, shall provide the Engineer with all labor, material, tools and equipment necessary to prepare test specimens for testing to satisfy the Engineer that the crossties are being furnished in accordance with these Specifications. The Contractor shall perform all tests and inspections for the Engineer prior to shipment at no additional cost to UTA.

F. Regular examination of the product will take place during normal working hours.

G. The Contractor shall give the Engineer written notice for inspection at least 30 days in advance of the initial in-shop inspection and 10 days in advance for subsequent in-shop inspections.

H. All material is subject to inspection by the Engineer at any time up to and including the time of delivery.

I. After material has been delivered and unloaded, an inspection will be conducted and a report issued by the Engineer. A report indicating no damage or shortages and material in good order will be required prior to payment.

3.12 TESTING AND INSPECTION

A. All testing and inspection shall be at the expense of the Contractor.

B. The Contractor shall provide not less than fourteen (14) days advance notice when any testing and inspection is to be performed unless otherwise specified herein. The Engineer retains the right to witness the tests.

C. Within seven (7) days after completion of testing, the testing firm shall submit six (6) certified copies of all test results including original data calculations and interpretation of results to the Engineer.

3.13 VISUAL INSPECTION

A. All concrete ties shall be visually inspected for defects, damage and non-conformance by the Contractor's quality control representative in the presence of the Engineer, when the ties are removed from their forms and stored, then again when the ties are delivered to the project site. Ties that are found to not meet the requirements of these specifications or that are determined to be structurally damaged or defective shall be removed from the project site and shall be replaced by acceptable materials at no additional cost to UTA. Ties that are found to be aesthetically damaged, but structurally sound will either be repaired by the Contractor at no additional cost to UTA, or may be accepted by UTA with a 50% price reduction if requested in writing by the Contractor.

3.14 CERTIFICATES OF COMPLIANCE

A. The Contractor shall furnish certificates of compliance for all ties. Have certificates signed by an authorized representative of the Contractor, stating that the material complies in all respects with the Contract requirements.

3.15 PACKAGING, HANDLING, LOADING, SHIPPING, UNLOADING AND STOCKPILING

A. Concrete crossties shall be handled in a manner to prevent chipping, spalling, cracking or other damage during loading, shipping, unloading and stockpiling. Do not drop or skid ties.

B. Securely brace ties for transportation to prevent any movement that could cause damage. Ship ties in a horizontal position, braced with wooden spacer blocks so that the top surface or cast-in-place hardware does not contact ties loaded above. Do not load ties higher than the top of the cars nor more than six layers deep.

C. Securely brace crossing panels for transportation to prevent any movement that could cause damage. Ship crossing panels in a horizontal position, braced with wooden spacer blocks so that the top surface does not contact panels loaded above.

D. Package rail fastener assembly parts separately to prevent damage during shipment and to facilitate handling. Do not mix different parts in the same package. Hardware shall be packaged in waterproof containers.

E. All concrete tie shipments shall be adequately prepared to preclude damage during shipment.

F. Within the area designated by the Engineer, store ties so that additional handling of the ties is unnecessary until the final distribution. Store the ties in separate stacks segregated according to type of tie. Unload ties from the car or truck in a manner that will not damage the ties. Do not drop or skid the ties from the truck bed to the ground. Provide the necessary supports and spacers so that the ties will not contact the ground during storage and that the top surface or rail fastener system hardware does not contact the ties stacked above. Supports and spacers shall be placed at the rail seat areas of the ties.

G. The Contractor shall replace all concrete ties and rail fastener assemblies damaged during loading, shipping, unloading and stockpiling with new concrete ties and rail fastener assemblies, respectively, at no additional cost to UTA.

END OF SECTION

SECTION 34 12 36

CRT – TIMBER TIES

PART I - GENERAL

1.1 SUMMARY

A. Description

1. The Work specified in this Section consists of manufacturing, treating, testing, handling and shipping timber crossties and switch ties as indicated and specified.

B. Related requirements

1. Section 34 12 23 - Special Trackwork
2. Section 34 12 27 - Trackwork – Ballasted Track Construction

1.2 REFERENCES

A. Reference Standards

1. American Wood Preservers Association (AWPA)
   a. AWPA A1, Analysis of Creosote and Oil-Type Preservatives
   b. AWPA A6, Determination of Oil-Type Preservatives and Water in Wood
   c. AWPA C6, Crossties and Switch Ties - Preservative Treatment by Pressure Processes
   d. AWPA M2, Inspection of Treated Timber Products
   e. AWPA M6, Brands Used on Forest Products
   f. AWPA P1, Preservative
   g. AWPA P2, Creosote Solutions
   h. AWPA P3, Creosote-Petroleum Oil Solution
2. American Railway Engineering and Maintenance-of-Way Association (AREMA) - Use Railway Engineering Manual, Volume I, Chapter 30 for this work unless superseded by more rigorous or specific requirements in this Section.

1.3 SUBMITTALS

A. Refer to General Provisions, for submittal procedures.

1. Executed inspector's report form as described by AWPA M2, including step-by-step work sheets of preservative analyses and retention assays, at least ten days before site delivery.

1.4 QUALITY ASSURANCE

A. The requirements, terminology, and standards for preservatives, conditioning, and treatment processes are those specified and recommended by the American Wood Preservers and Association (AWPA), except as modified herein.

B. The requirements, terminology, and standards for timber grading, inspection, and manufacturing are those specified and recommended by the West Coast Lumber Inspection Bureau (WCLB), except as modified herein.

C. The requirements, terminology, and standards for handling and machining timber are those specified and recommended by the American Railway Engineering and Maintenance-of-Way Association (AREMA), except as modified herein.

D. Provide equipment used for artificial seasoning and treatment of timber ties that is in good repair. Calibrate gauges and metering devices within twelve months prior to treatment.

1.5 ACCEPTANCE

A. Acceptance by the materials in this Section shall be by AREMA Chapter 30 specifications and other codes as applicable.

B. Unless otherwise permitted by the UTA, remove any rejected materials from the Worksite.

PART II - PRODUCTS

2.1 TIMBER TIES

A. Species

1. Switch ties - Mixed hardwoods

2. Crossties and bridge crossties

a. Western species - Douglas Fir, Hemlock, Spruce. Hemfir will not be accepted.

b. Southern species - Red Oak, Pecan, White Oak, Red Gum, Cypress, Black Gum, Birch, Tapelo, Elm, Magnolia, True Hickory, Hard Maple, Hickory, Southern Pine.

B. Physical Property Requirements

1. Provide ties that are free from defects which may impair their strength or durability, such as decay, large splits, large shakes, slope of grain, large holes, or large knots.

2. Provide ties that have a rate of growth classification of either close grain or dense material.

3. Provide ties containing no decay. Although blue stain is not decay, ties will be inspected for the presence of decay in heavily stained areas.

4. A hole is not acceptable in critical areas if it exceeds $^1/_2$ inch in diameter and three inches in depth. A hole is not acceptable in noncritical areas if its diameter exceeds one fourth of the width of the surface on which it appears, and three inches in depth. The critical and noncritical areas for timber crossties and switch ties are described in Paragraph 2.1 L.

5. A knot is not acceptable in critical areas if its average diameter exceeds one fourth of the surface's width on which it appears. A knot is not acceptable in noncritical areas if its average diameter exceeds one third of the width of the surface on which it appears. Numerous small knots are not acceptable if they equal the damaging effect of a large knot.

6. Provide well-manufactured ties with surfaces that are even and not scored to a depth greater than $^1/_4$ inch in critical areas, or $^1/_2$ inch in noncritical areas. Double end trim with both ends cut square, free of bark, and with parallel sides. Ties are parallel if a difference in thickness at the sides or ends does not exceed $^1/_2$ inch.

7. Seasoning checks are acceptable on all faces if the depth of the check in a seasoned tie is less than $^1/_4$ inches and the check length is shorter than one half of the length of the tie.

8. Shakes are acceptable if they do not exceed one third of the width of the tie and appear only on the ends of the tie.

9. Splits are acceptable if the separation of the wood, after treatment, extending from one surface to an opposite or adjacent surface is less than 1/8 inch wide and/or four inches long. For switch ties, splits are acceptable if the separation of the wood, after treatment, is no more than ¼ inch wide and/or shorter than the width of the face across which it occurs.

10. Provide ties in which the slope of the grain does not exceed one inch in 15 inches.

11. A bark seam or a bark pocket will be acceptable provided that it is not deeper than two inches at any point and/or is less than 10 inches long.

12. Critical areas of ties regarding holes and knots are as follows:

    a. On crossties the top, bottom, and sides in the two 20-inch-long portions between 20 and 40 inches from the track centerline.

b. On switch ties the top, bottom, and sides in the full length of the tie except for the last 12 inches on each end.

C. Sizes and Tolerances

1. Crossties - Seven inches deep by nine inches wide, and eight feet six inches long (AREMA 7" Grade).

2. Bridge Crossties - Seven inches deep by nine inches wide, and nine feet long (AREMA 7" Grade).

3. Switch Ties - Seven inches deep by nine inches wide. Length requirements as indicated on the Contract Drawings.

4. Size and Length Tolerances:

a. Width - plus one inch, minus zero inches.

b. Depth - plus one inch, minus zero inches.

c. Length - plus one inch, minus zero inches.

d. Wane at a tie top corner in critical areas will be acceptable if the surface width is not reduced to less than eight inches. At other areas the wane may reduce the surface width to seven inches.

PART III - EXECUTION

3.1 INSPECTION

A. Testing/Inspection shall be done in compliance with Project Quality Plan.

B. The testing service shall submit timely, professional test reports containing a description of each test, identification of test equipment along with current calibration certificates, an explanation of all deviations of test procedures, tabulations and/or plots of test results, the testing service’s evaluation of the results, and sketches or diagrams necessary to clarify the tests or results.

C. The Engineer may exercise the right to observe the timber tie production process, without advance notice, to verify compliance. Whether or not the Authority inspects or tests any materials, the Contractor will not be relieved from any responsibility regarding defects or other failures to meet the Contract requirements, nor will such inspection or testing be considered as a guarantee or acceptance of any material which may be delivered later for incorporation into the Work. Final acceptance of timber ties will be given when the ties have been acceptably installed in the finished track.

D. Provide inspection branding confirming timber grading, using a hammer brand in accordance with WCLB requirements.

3.2 SEASONING

A. Timber crossties and switch ties shall be incised prior to seasoning in accordance with AREMA Manual for Railway Engineering, Chapter 30, Section 3.6.2, “Preparation of Material Prior to Treatment.”

B. Season timber crossties and switch ties. Dry timber ties manufactured from red or white oak to an oven dry moisture content of 50 percent or less prior to preservative treatment. Dry timber ties manufactured from other hardwood species to an oven dry content of 45 percent or less prior to preservative treatment. Dry Western and Southern softwoods to an oven dry moisture content of 29 percent or less prior to preservative treatment. The wood may be air dried, vapor dried, or boultenized. Indicate in submittals the type of seasoning utilized.

C. Season and treat ties dried by artificial means as soon as possible after sawing but in no case more than 30 days later.

D. Transfer vapor dried ties from drying cylinders to treatment cylinders as quickly as possible to avoid loss of heat from the seasoned ties.

E. Prior to conditioning or immediately before preservative treatment, the ties shall be machined per AREMA Manual for Railway Engineering, Chapter 30, Section 3.1.4.

3.3 TIE MACHINING AND MANUFACTURE

A. Conform to the AREMA Manual, Volume 1, Chapter 30, Section 3.1.4.

B. At the time of machining, turn ties as necessary to establish the top surface. In general, turn heartwood side down. Where the tie includes the heart make the top surface that which is furthest from the heart. Perform machining before treatment.

C. Prebore crossties for the lag screws used in each tie plate, as indicated. Tie plates are specified in Section 34 12 93 – Other Track Materials. Ensure that preboring will result in track gauge within the tolerances specified in Section 34 12 27 – Ballasted Track Construction. If gauge tolerance compliance is suspect, prebore for only one rail and bore the tie for the other rail at time of field installation.

D. Anti-Splitting Devices - Equip switch ties with anti-splitting devices prior to treatment.

1. Apply dowels or gang nail plates in accordance with the manufacturers' written installation procedures while the four faces of the tie are securely clamped so as to close splits.

2. If gang nail plates are used, cut a kerf $^{1}/_{8}$ inch deep in the top surface of the tie four to six inches from each end.

E. Ensure that identification branding conforms to AWPA M6.

F. Perform pretreatment tie top surface adzing as necessary for the full length and width of the critical areas.

G. Incise all four tie faces in the patterns given in the AREMA Manual.

3.4 PRESERVATIVE TREATMENT

A. Treat switch ties with AWPA P1 preservative.

B. Treat crossties and contact rail ties with AWPA P1, AWPA P2, or AWPA P3, maintaining a minimum of 50 percent creosote in the preservative.

C. Preservatives, Conditioning, and Treatment Processes - Conform to AWPA C6, with the following modifications:

1. Provide empty cell process treatment, using an expansion bath with final vacuum.

2. Provide results of treatment meeting each of the following minimal requirements:

a. Minimum retention of eight pounds per cubic foot, or refusal

b. $^{3}/_{4}$ inch average penetration, with a minimum of $^{1}/_{2}$ inch

c. 90 percent of sapwood penetrated

D. Provide ties free of excess preservative. Ties exuding minor amounts of preservative will be permitted.

E. Perform preservative quality analysis in conformance with AWPA A1.

F. Perform preservative retention analysis in conformance with AWPA A6.

3.5 INSTALLATION

A. Installation of timber ties is not part of the Work of this Section. For installation requirements, refer to Section 34 12 27 – Trackwork – Ballasted Track Construction.

3.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Conform to AREMA Manual, Chapter 30, Part 3.

B. Segregate the treated ties by types (cross or switch ties) and lengths.

C. Bundle ties for shipment by type and length, and in groups weighing four tons or less. Place the identification brand on the visible side and protect ties from the metal bands.

D. Obtain post-treatment inspection and conditional acceptance by the Engineer before installing ties in track.

END OF SECTION

SECTION 34 12 37

CRT – CONCRETE GRADE CROSSING PANELS

PART I - GENERAL

1.1 SUMMARY

A. Description

1. This Specification defines the requirements for the design, manufacture, supply, inspection, testing and delivery of concrete grade crossing panels.

2. The commuter rail track will be constructed with 115RE rail and will be mounted on concrete ties.

B. Related Requirements

1. Section 34 12 35 – Concrete Ties

2. Section 34 12 36 – Timber Ties

1.2 REFERENCES

A. Precast concrete grade crossing panels shall be designed, manufactured, tested and inspected in accordance with the BNSF/ UPRR Common Standards listed below, except as modified herein.

Number	Subject
200100	LAYOUT FOR CONCRETE PANELS ON 10’-0” LONG WOOD TIES (10W)
200102	PRECAST CONCRETE PANELS FOR 10’-0’ LONG WOOD TIES (10W)
200300	LAYOUT FOR CONCRETE PANELS ON 10’-0” LONG CONCRETE TIES (10C)
200302	PRECAST CONCRETE PANELS FOR 10’ CONCRETE TIES (10C)
200900	TYPICAL DETAILS FOR CONCRETE PANELS
200901	GENERAL SPECIFICATIONS FOR ROAD CROSSINGS WITH CONCRETE PANELS
200902	CURVED CONCRETE PANELS
200903	SHUNT RESISTANCE TEST FOR CONCRETE PANELS

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General

Provisions except as modified herein.

B. Submit or retain the following:

1. Evidence of compliance with the general requirements of the BNSF / UPRR Common Standards, including manufacturer certification in accordance with ISO 9000 or AAR M-1003.

2. Evidence of compliance with the materials specifications of the BNSF / UPRR Common Standards, including the specifications for the permanently preattached flangeway filler.

3. Quality Control Program Plan, including evidence of compliance with the special testing requirements of the BNSF / UPRR Common Standards. Submit within thirty (30) days of Notice to proceed.

1.4 QUALITY ASSURANCE

A. Not Applicable.

1.5 ACCEPTANCE

A. Not Applicable.

PART II - PRODUCTS

2.1 CONCRETE GRADE CROSSING PANELS

A. Grade crossing panels for commuter rail track shall match the 115 RE rail section. The Grade Crossing Panel Contractor shall modify the BNSF / UPRR Common Standards for the 10C grade crossing panel to match the height of the 115RE rail section.

B. All grade crossing panels for UPRR track will be designed for 136 RE rail mounted on wood ties.

2.2 RUBBER INTERFACE PAD

A. The Grade Crossing Panel contractor shall provide ¼” conformal rubber interface pads for each concrete tie under a grade crossing panel (per the note on BNSF / UPRR Common Standard drawing 200300).

B. The conformal rubber interface pads shall be shipped either in advance of or with their grade crossing panels.

PART III - EXECUTION

3.1 HANDLING, DELEVERY, AND STORAGE

A. Concrete grade crossing panels and components shall be handled only by means of acceptable handling devices.

B. The concrete panels shall be delivered in flat deck vehicles and shall be braced

during transportation to prevent any movement that could cause damage. The concrete panels shall be delivered in a horizontal position, loaded no more than 6 layers deep, and shall be braced with wooden spacer blocks.

END OF SECTION

SECTION 34 12 38

CRT – RAIL WELDING

PART I - GENERAL

1.1 SUMMARY

A. Description

1. This Specification defines the requirements for the furnishing of labor, material, equipment, and services necessary for the welding of rail sections into Continuous Welded Rail (CWR) strings using the electric flash butt and the aluminothermic (thermite) welding process.

   a. The electric flash butt welding process shall be used to join continuous welded rail strings in the shop into the longest lengths practical for the site condition, but not exceeding 1,600 feet.

   b. All field welds of continuously welded rail strings, all rail joints in curves with a radius less than 500 feet, and rails in the yard, shall be welded by the aluminothermic welding process.

B. Related requirements

1. Section 34 12 45 – Trackwork – Field Rail Welding.

1.2 REFERENCES

All welding of rails shall conform to the current AREMA, *Manual for Railway Engineering,* and Chapter 4 - Rail or equivalent, except as modified herein.

Sponsor	Number	Subject
AREMA	Chapter 4 Sec. 2.3	Slow Bend Test
ASTM	E 164	Ultrasonic Contact Examination of Weldments
ASTM	E 709	Magnetic particle Examination
ASTM	E 94	Standard Guide for Radiograph Examination

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein.

B. Retain the following:

1. Daily report of field welding records

2. Test procedures

3. Certified test results

1.4 QUALITY ASSURANCE

A. Quality assurance/quality control shall be in accordance with the requirements of the Quality Plan and the General Provisions, except as modified herein.

1.5 ACCEPTANCE

A. Not Applicable.

PART II - PRODUCTS

2.1 FLASH BUTT WELDING EQUIPMENT

A. The flash butt welding process shall use an industry recognized electric flash butt unit for rail welding. The following flash butt welding plant equipment shall be furnished as a minimum:

B. Hydraulic device for aligning and straightening rails

C. Welding head with electric current monitoring equipment

D. Chart recorder providing data on welding current, time, force, and velocity

E. Rail pusher and/or loader for moving welded rail

F. Power generator

G. Shelter for welding components from inclement weather

2.2 THERMITE WELDING EQUIPMENT

A. The thermite welding process shall use Calorite, Thermite, Boutet, or equivalent proprietary welding kits.

B. The Contractor shall provide information regarding the specific manufacturer’s requirements for:

1. Pre-heating temperature and duration

2. Rail joint gap

3. Welding gases mixture and quality

4. Standard appurtenances

5. Procedures

PART III - EXECUTION

3.1 RAIL STRAIGHTENING

A. Prior to welding of rails, each rail shall be inspected for vertical and horizontal end deflection, and will be accepted for welding based on meeting the following criteria:

1. Deviation

a. Deviation of the horizontal line in either direction at the rail ends shall not exceed a maximum tangent offset measured at the end of the rail from the nearest point of deviation from a straight line projection as indicated below.

Distance of Nearest Deviation to Rail End (inches)	Maximum Tangent Offset at Rail End (inches)
18	$^1/_{32}$
9	$^1/_{64}$
5	$^1/_{128}$

2. Upsweep/Downsweep

a. Uniform surface upsweep at the rail ends shall not exceed a maximum ordinate of $^1/_{32}$ inch in 3 feet, and the $^1/_{32}$ inch maximum ordinate shall not occur at a point closer than 18 inches from the rail end.

b. Surface downsweep in rail ends will not be acceptable.

c. Any rail not within the above-specified tolerances shall be straightened to the required tolerances. Any rail sections that cannot be straightened shall be cut back a sufficient distance to achieve the required tolerances.

3.2 RAIL CUTTING AND ROLLING

A. All rails cut for any reason shall be clean and square by means of reciprocating rail saws or abrasive cutting saws. Torch cutting of rail is not permitted.

B. Holes shall not be permitted in the rail, except as required for the installation of bonded joint bars, rail anchors and shop tracks.

3.3 RAIL END PREPARATION

A. Flash Butt Welds

1. All rails for electric flash butt welding shall have the scale and raised rolling marks removed down to bright metal in those areas of the rail where the welding current-carrying electrodes contact the rail. The weld and adjacent rail for a

distance clearing the electrodes shall be rejected if in the areas of electrode contact there is not more than 95% of the mill scale removed. Rails showing evidence of electrode burns, where the metal has been displaced, shall be rejected.

B. Thermite Welds

1. All rails for thermite welding shall have the scale and raised rolling marks removed down to bright metal in those areas of the rail extending a minimum of 12 inches to each side of the weld joint.

3.4 WELDING

A. Flash Butt Welding

1. The alignment of the rail in the welding machine shall be performed at the head of the rail.

2. Vertical alignment shall provide for an accurately aligned running surface. Any difference in height of rails shall be in the base.

3. Horizontal alignment shall be made on the gauge side of the head of the rails. Any deviations in the width of the heads shall occur on the field side.

4. All electric flash butt welds shall be forged to point of refusal to further plastic deformation and have a minimum upset of $^{3}/_{8}$ inch. If flashing of electric flash butt welds is interrupted with less than ½ inch of flashing distance remaining before upsetting, the rails shall be re-clamped in the machine and flashing initiated again.

B. Thermite Welding

1. The thermite welding procedure shall be in accordance with the weld kit manufacturer's instructions for both the short and extended pre-heat processes. The quick preheat procedure shall be used subject to the successful completion of the qualification test as specified herein. If unacceptable welds are produced with this procedure, the Contractor shall use the extended preheat procedure, subject to similar qualification requirements.

3.5 FINISHING AND ALIGNMENT

A. Finishing Rail Welds

1. Trimming and grinding of all rail welds shall result in the weld being within the following tolerances:

a. The top and sides of the rail head shall be finished to within + $^{1}/_{32}$ inch - 0 inch of the parent Section.

b. The bottom and sides of the rail base shall be finished to within + $^{1}/_{32}$ inch - 0 inch of the parent Section.

c. The web, top of rail base and the underside of the head shall be cleaned by using a wire brush. Any weld metal overlapping the edge of the weld (shear drag), shall be removed by grinding. Test welds and the first six welds of the production welding operations shall be finished to within + $^1/_8$ inch and - 0 inch of the parent section.

d. Finishing shall eliminate all cracks visible to the unaided eye and shall leave an area 6 inches each side of the weld smooth and free from spatter or rough surfaces which might inhibit weld testing.

e. Notches created by offset conditions shall be eliminated by grinding to blend variations.

f. Protrusions and gouges in the weld areas shall be removed and the weld area shall be blended into the rail contour in a manner which will eliminate fatigue crack origins.

2. Whenever possible, grinding of the rail shall be performed immediately following welding at an elevated temperature. When grinding must be performed at normal temperature, care shall be exercised to avoid grinding burns and metallurgical damage.

B. Alignment of Rail Welds

1. The alignment of the welded rails shall meet the following minimum requirements:

a. The crown of the rails at the weld shall not be greater than $^1/_{16}$ inch in 36 inches measured from the weld point for flash butt welds, and $^1/_8$ inch in 36 inches for thermite welds. The crown tolerance is the combined vertical offset and crown camber measured using a 3 foot or longer straight edge. To achieve the specified crown tolerances, surface grinding of the welded rail is permitted.

b. The alignment of the rails at the weld shall not deflect more than $^1/_{16}$ inch in 36 inches measured from the weld point for flash butt welds, and $^1/_8$ inch in 36 inches for thermite welds. The alignment is the combined horizontal offset and kink camber. To achieve the specified alignment tolerances, the use of a hydraulic press is permitted.

3.6 WELDING QUALIFICATION TESTING

A. All qualification testing shall be performed by an independent testing agency accepted by UTA. Welding qualification testing specified herein is intended to qualify the welding plant, welding process and procedures, and welding crews. Any changes to the above shall require re-qualification.

1. Dry Powder Magnetic Particle and Wet Fluorescent Tests

a. Prior to start of production welding, six sample welds produced by the electric flash butt welding process and the thermit process shall be tested using the dry powder method of magnetic particle inspection in accordance with ASTM

E709, or acceptable equivalent. A 5x power magnifying glass shall be used in examining questionable indications. Any signs of fault indications shall be further tested by the wet fluorescent method.

b. Sharp indications on the butt line and outside the butt line that are over $^{1}/_{16}$ inch in length shall be rejected. If a defective weld is detected, the welding procedure shall be modified and the tests shall be repeated.

2. Ultrasonic Test for Sample Welds

a. The six weld samples from each welding process shall be prepared for ultrasonic testing. Samples shall be prepared by the Contractor's welding crews in accordance with the accepted method and procedure.

b. All sample welds shall be ultrasonically tested for defects and in accordance with ASTM E164, or approved equivalent. The testing agency shall perform an ultrasonic testing procedure which shall indicate incompletely fused welds. As a minimum, the weld shall be scanned at three angles: one at 0 degrees; one at 45 degrees; and one at 70 degrees. The ultrasonic equipment shall be capable of detecting a $^{1}/_{16}$ inch discontinuity within a weld.

c. The sensitivity and resolution of the proposed instruments shall be demonstrated using appropriate area amplitude and distance amplitude reference blocks made of material similar to the rail steels being tested. All instruments shall be equipped with a distance amplitude correction feature and shall be calibrated daily using an actual rail section with machined defects of known size.

d. The weld shall be rejected if any discontinuities greater than $^{1}/_{16}$ inch are discovered.

e. All inspection and testing personnel shall be qualified technicians in accordance with the applicable local, state, or national board requirements.

3. Visual Test for Sample Welds:

a. All sample welds shall be visually inspected for surface defects. Welds with surface cracks visible to the unaided eye shall not be accepted.

b. Welds not meeting the following minimum requirements shall be rejected:

1) Each weld shall have complete fusion with no evidence of surface or internal fissures or cracks.

2) Porosity or slag type defects shall not exceed $^{1}/_{16}$ inch in any dimension. Any crack indications in or adjacent to the weld shall be cause for rejection of the weld.

3) If a defective weld is detected, the welding procedure shall be modified and the tests shall be repeated in sequence.

c. Microetch and Macroetch Tests:

1) One sample weld shall be sectioned longitudinally, polished and etched. Microetch and macroetch specimens shall be prepared and the grain structures evaluated by a competent metallurgist from an independent testing laboratory. The specimens shall demonstrate homogeneity of the weld.

d. Welding Electric Current, Time, and Force Data:

1) All sample flash butt welds shall be monitored on a chart recorder for welder head movement and welder current draw as a function of time, including a description of the pulsation duration, flashing duration, welding force, welding velocity and upset distance.

2) The data recorder shall show consistent patterns in all significant welding parameters among sample welds tested and accepted.

3) The chart recording shall be marked with string and weld number, shall be made available to the UTA during construction and be provided to the UTA for permanent records prior to issuance of Certificate of Substantial Completion.

e. Assessment of Sample Welds

1) Should any sample weld fail to meet any of the above specified requirements, the welding process, including the welding crew, shall be re-qualified as determined by the Contractor and approved by the UTA. Should any supervisor of the welding crew be replaced during the work, the welding crew shall be re-qualified under the new supervisor.

f. Welding Parameters

1) Welding parameters critical to the end results, such as current draw, pre-heat time, welding force, upset distance and other critical parameters shall be established by the Contractor during successful completion of the Welding Qualification Testing program specified herein.

2) Critical welding parameters and non-destructive testing operations shall govern the acceptance or rejection of the production welds.

3.7 WELD PRODUCTION TESTING

A. All production testing shall be performed by an independent testing laboratory retained by the Contractor. Production testing by this testing laboratory shall be performed adjacent to the welding and grinding stations, and shall be incorporated within the Contractor’s production sequencing of the welding with minimal interruption to the Contractor’s work. The Contractor shall coordinate with the laboratory to accommodate the testing operations at the welding site by providing adequate space, electric power and services, and protection from inclement weather.

1. Dry Powder Magnetic Particle and Wet Fluorescent Tests

    a. All flash butt production welds shall be tested in the same manner as defined under the corresponding section of Welding Qualification Testing. Welds showing any sign of specified fault indications shall be cut out and re-welded, and then be re-inspected and tested. Field thermit welds shall not require either magnetic particle or wet fluorescent inspection.

    b. Ultrasonic and Visual Tests

        1) All production welds shall be tested in the same manner as defined under the corresponding section of Welding Qualification Testing. Welds showing any sign of specified fault indications shall be cut out and re-welded, and then be re-inspected and tested.

    c. Defective Field Weld Repair

        1) Defective field welds detected in the finished track shall be repaired by one of the following methods as determined by the Contractor, at no cost to the UTA.

    d. The defective weld shall be cut out a minimum of 12 inches each side of the weld, and the rails shall be re-welded using the thermit welding process. If a rail plug is required, a new section of rail not less than 13’ long shall be inserted and joined together with bonded rail joints.

END OF SECTION

SECTION 34 12 45

CRT – TRACKWORK – FIELD RAIL WELDING

PART I - GENERAL

1.1 SUMMARY

A. Description

1. This Section specifies the following:

a. This Section specifies the furnishing, installation and testing of field rail welds to connect CWR strings and/or rails as shown on the Contract Drawings and as specified herein.

b. The furnishing and installation of an on-site electric-flash butt rail welding plant and/or a mobile electric-flash butt rail welding plant. The location of the fixed on-site welding plant shall be determined by the Contractor. The owner has made provisions for storage areas for continuous welded rail. During the course of these operations the Contractor may decide to move and install the fixed welding plant at more than one location as required.

c. The Contractor shall, wherever possible, utilize a mobile electric-flash butt welding plant to satisfy the requirements of this Section.

d. Qualification testing, production testing, and inspection.

2. Upon completion of fixed on-site and/or mobile plant welding operations, the Contractor shall remove from the job site all plant welding facilities, surplus or discarded materials, and rehabilitate the job site to conditions approved by the Engineer.

B. Related Sections:

1. Section 34 12 38 - Rail Welding

1.2 REFERENCES

Sponsor	Number	Subject
AREMA	Vol. I Manual for Railway Engineering, - Specifications, Part 2 Specifications	
ASTM	E 10	Test Method for Brinell Hardness of Metallic Materials

ASTM	E 94	Standard Guide for Radiographic Examination
ASTM	E 164	Practice for Ultrasonic Contact Examination of Weldments
ASTM	E 709	Practice for Magnetic Particle Examination
ASNT	CP-189	Standard for Qualification and Certification of Nondestructive Testing Personnel
AWS	D 1.1	Structural Welding Code

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein. Submittals shall include:

1. Field and mobile electric-flash butt welding procedure Specification.
2. Procedure qualification test results.
3. Thermite and mobile electric-flash butt welder performance qualification records.
4. A daily report of field welding records.
5. Certified material test reports for the thermite powder portions.
6. Welding supervision qualifications.
7. Identification of the testing service, their testing program and procedures, and a copy of their agreement.

1.4 QUALITY ASSURANCE

A. Quality assurance/quality control shall be in accordance with the requirements of the Quality Plan and the General Provisions, except as modified herein.

1.5 ACCEPTANCE

A. Not applicable.

PART II - PRODUCTS

2.1 MATERIALS

A. Electric-flash Butt Welding Process

1. The Contractor shall submit a written description of welding ability, including facilities, personnel and list of similar, completed projects.

2. New and/or relay rail welding shall be by the electric-flash butt welding process and shall conform to AREMA Specifications for Fabrication of Continuous Welded Rail, except as modified herein. All production welding shall use procedures stated below.

3. Each welding machine, whether for use at a fixed on-site or a mobile plant, shall be equipped with a brush recorder to produce charts showing traces of electrical impulses and movable platen travel. A chart shall be submitted to the Engineer for each weld. If the chart indicates performance which is not in conformance with the approved standards, the weld shall be rejected.

4. The Contractor shall furnish all electric power and utilities required for the work.

B. Thermite Welding Kit:

1. For welds that can not be performed with an on-site electric-flash butt rail welding plant, the Contractor shall select and furnish a welding kit that conforms to the requirements of AREMA "Thermite Welding - Rail Joints", except as modified herein. The thermite welding kit material manufacturer shall certify the thermite powder portions are in compliance with the referenced requirements.

PART III - EXECUTION

3.1 WELDING PROCEDURES

A. Electric-flash Butt Welding Process

1. All welding procedures and methods for making mobile electric-flash butt welds shall conform to the requirements AREMA “Specifications for Fabrication of Continuous Welded Rail" and "Specifications for Steel Rails".

B. Thermite Welding process

1. All welding procedures and methods shall conform to the requirements of AREMA "Thermite Welding - Rail Joints", except as modified herein.

3.2 PROCEDURE SPECIFICATION

A. The Contractor shall prepare a detailed procedure Specification for the Engineer's review and approval covering step-by-step procedures to be employed in making mobile electric-flash butt welds and field thermite welds. A complete description of each of the following items and any other essential characteristics shall be included in the procedure Specification.

1. Manufacturer's trade name for welding process.

2. Method used for cutting and cleaning of rail ends. Flame cutting of rail ends will not be allowed.

3. Minimum and maximum gap between rail ends.

4. Method and equipment used for maintaining rail gap and alignment during welding.

5. Method used for preheating rail ends including time and temperature.

6. Tapping procedure including minimum time required to cool weld under the mold insulation.

7. Method used for removing gates and risers and finishing weld suitable for radiographic inspection, including a description of special tools and equipment.

8. The manufacturer's recommended procedure for welding premium rail if different from requirements for standard rail.

9. Quality control procedures.

3.3 QUALIFICATION OF FIELD WELDING PROCEDURE

A. The Contractor shall qualify the procedure Specification described above by preparing and testing eight qualification test welds prior to beginning production welding. The qualification test welds shall be prepared by the contracting welding crews in conformance with the procedures listed above on short lengths of rail. Four welds for each welding process shall be demonstrated. Two test welds on 115 RE rail to 115 RE rail and two test welds on 115 RE rail to 136 RE rail for each process.

B. The qualification test welds shall be inspected and tested by the testing service in accordance with the following requirements:

1. Paragraph 3.4, Weld Quality

2. Paragraph 3.13, Weld Numbering Field Welding Record Weld Inspection and Testing

3. Paragraph 3.14, Weld Inspection

4. Paragraph 3.15, Ultrasonic Weld Testing

5. Paragraph 3.16, Magnetic Particle Testing

C. The qualification test weld shall be sectioned longitudinally through the middle of the rail and chemically etched. The etch shall show a clean definition of the weld metal and heat affected zone of the weld joint. The testing service shall examine the etched sections for conformance with the weld quality requirements of Paragraph 3.4, below. One of the etched sections and the report of the testing service shall be submitted to the Engineer.

D. The procedure Specification will be considered qualified if the weld kit and the mobile electric-flash butt welding plant and all tests and inspections meet or exceed the acceptance requirements. If any test or inspection is failed, the Contractor shall submit

and qualify a revised procedure Specification in accordance with the requirements herein.

E. Production field welding shall not begin until a procedure Specification is qualified in accordance with the requirements herein.

3.4 WELD QUALITY

A. Each weld shall have full penetration and complete fusion and be free of cracks.

B. Small porosity and slag inclusion which show on radiographic film will be accepted if the total area of internal defects does not exceed 0.09 square inches and the largest single defect does not exceed 0.180 inch in diameter.

3.5 WELDING SUPERVISION

A. All welding shall be performed under the direct supervision of a welding foreman or supervisor with a minimum of five years documented experience supervising field welding. In addition, a manufacturer's representative, experienced in thermite and/or mobile electric-flash butt welding, as appropriate for the welding method used, shall be present at the job site on an as-needed basis and shall witness the making of thermite and/or mobile electric-flash butt welds, for acceptance.

3.6 WELDING REQUIREMENTS

A. Rail End Preparation: The rails to be welded shall be cleaned of all grease, oil, dirt, loose scale and moisture to a minimum of six inches back from the rail ends, including all the rail surface, by use of a wire brush, to completely remove all dirt and loose oxide, and by use of oxy-acetylene torch under a minimum temperature of 250-degrees F to remove any grease, oil or moisture. The face of the rail ends shall be aligned and arranged at right angles and cut by using a power actuated saw, or abrasive rail cutting machine, and further cleaned to remove all scale and rust by use of a power actuated grinder with abrasive wheel for two inches on each side of the weld. Rail ends shall show no steel defects, dents, or porosity before welding. All burrs and lipped metal which would interfere with the fit of the mold shall be removed.

B. Weld Gap: The minimum and maximum gap shall be in accordance with the Specifications for the type of thermite or mobile electric-flash butt weld being made, and as provided by the manufacturer of the weld kit or the mobile electric-flash butt welding plant. The minimum measurement shall be made with a go or no-go gauge made of the specified dimensions for the thermite or the mobile electric-flash butt process used. The gap must be adjusted if under the minimum or more than $^{1}/_{8}$ inch over the specified gap.

C. Sealing the Molds: No mold sealant or luting material shall be introduced into the weld chamber.

D. Preheating: The rail ends shall be preheated, prior to welding, to a sufficient temperature and for sufficient time, as indicated in the approved procedure Specification, to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld. The rail temperature shall be checked by the use of tempilsticks, or as directed by the Engineer.

E. Post heating: The molds for thermite field welds shall be left in place after tapping for sufficient time to permit complete solidification of the molten metal and proper slow cooling to prevent cracking and provide a complete weld with proper hardness and ductility.

F. Weather: Welding shall not be done during periods of precipitation, winds of 25 m.p.h. or more, or electrical activity except by permission of the Engineer and with sufficient protection to ensure adequate protection of the weld materials.

G. Other Work: During the setting up and actual welding, other work which would in any way move, vibrate, or otherwise interfere with the welding outcome will be prohibited. Necessary precautions shall be taken to prevent disturbing the weld immediately after the pour when working adjacent to a grade crossing.

H. Storage of Thermite Welding Materials: Crucibles, molds and thermite mix portions shall be stored in a dry location in order to prevent moisture contamination. Thermite mix portions stored beyond their shelf life shall not be used.

I. Only standard preheat will be allowed. Weld kits must be new.

3.7 LOCATION

A. The Contractor shall locate field welds in accordance with the following:

1. Field welds in opposite rails shall be staggered a minimum of 10 feet for connecting CWR strings and a minimum of 2 feet at all other locations, except as otherwise accepted by the Engineer.

2. Field welds shall not be located within street intersections or grade crossings or within 8 feet of the end of a grade crossing.

3. Field welds shall not be located within 15 feet of a bolted rail joint.

4. Field welds shall not be positioned within three inches of a tie plate.

5. Field welds shall not be located within 13' of another field weld on the same rail or within 5 feet of a shop weld on the same rail, unless approved by the Engineer.

3.8 ALIGNMENT

A. The ends of the rails to be welded shall be properly gapped and aligned to produce a weld which will conform to the following alignment tolerances. The rail gap and alignment shall be held by a hydraulic rail puller/expander and alignment jig without change during the complete field welding cycle.

B. Alignment of rail shall be done on the head of the rail.

1. Vertical alignment shall provide for a flat running surface. Any difference of height of the rails shall be in the base.

2. Horizontal alignment shall be done in such a manner that any differences in the width of heads of rail shall occur on the field side.

C. Horizontal offsets shall not exceed 0.040 inch in the head and 0.125 inch in the base.

D. Surface Misalignment Tolerance

1. Combined vertical offset and crown camber shall not exceed 0.040 inch per foot at 60-degrees F.

2. Combined vertical offset and dip camber shall not exceed 0.010 inch per foot at 60-degrees F.

E. Gauge Misalignment Tolerance: Combined horizontal offset and horizontal kink shall not exceed 0.040 inch per foot at 6-degrees F.

3.9 FINISHING

A. The weld shall be finished with a rail mounted rail head grinder specifically designed for the work. Finishing shall conform to the following tolerances:

B. Top of rail head, plus 0.010 inch to minus 0 inch of the parent rail section.

C. Sides of rail head, plus or minus 0.010 inch of parent rail section.

D. The balance of the rail section shall be finished with a hand-held grinder as required to remove notches, protrusions, gouges, visible cracks and other defects. All grinding shall blend to the parent rail section and shall not overheat the steel. Heavy grinding shall be completed while the steel is still hot from welding.

3.10 WELD NUMBERING

A. Mark a sequential weld number on the rail immediately adjacent to the weld using a quality lead paint marker at the time the weld is made.

B. Number welds sequentially in the order in which they are made.

C. The Engineer will provide the Contractor with the initial weld number.

D. When defective welds are replaced, assign a new sequential number to the new weld by adding a letter to the defective weld number.

3.11 WELD NUMBERING FIELD WELDING RECORD

A. Field welding records shall be maintained by the Contractor and submitted to the Engineer on a daily basis during the production of field welds. These records shall include:

1. Date and time welded

2. Weld number

3. Location by station stating track and rail

4. Type of joint - Std to Std, Premium to Premium, Std to Premium

5. Contractor's welding personnel
6. Engineer's representative
7. Manufacturer's representative
8. Rail gap (nearest $^{1}/_{16}$ inch)
9. Weather, air and rail temperature
10. Weld trade name
11. Track alignment (curve, tangent, etc.), anchorage and rail stress
12. Inspection date
13. Inspector's name
14. Inspection results
15. Testing date
16. Evaluator's name
17. Test results

3.12 QUALIFICATION OF WELDING CREW

A. Prior to production welding, each crew, including foreman or supervisor of that crew, shall prepare a qualification weld in 115 RE rail, out of track, at the expense of the Contractor. The weld shall be prepared in accordance with the approved procedure Specification and will be witnessed by the Engineer.

1. Testing: Qualification weld shall be visually inspected, by magnetic particle and for hardness.

2. Acceptable Criteria: Weld quality requirements of Paragraphs 3.4 and 3.5.

3. Test Record: The test record shall contain the names of the crew members, including foreman or supervisor of that crew, who performed the qualification weld and briefly describe their specific duties. The test records shall also show results of and magnetic particle testing. All performance qualification records shall be submitted to the Engineer at least 14 calendar days prior to production welding. Production welding shall not commence until qualification test welding records have received written approval by the Engineer.

4. Requalification: The Engineer reserves the right to require the requalifications, at the Contractor's expense, of any crew of welders whose work fails to meet the specified requirements.

3.13 WELD NUMBERING FIELD WELDING RECORD WELD INSPECTION AND TESTING

A. All field weld inspection and testing shall be carried out by an independent testing service, selected by and at the expense of, the Contractor. The testing service and their testing program and procedures shall be subject to the approval of the Engineer.

B. The Contractor shall submit a copy of his agreement with the testing service to the Engineer for approval. The agreement shall specify that the testing agency is directly responsible to the Engineer, that all subsequent communication between the testing services and the Contractor regarding the work under this Contract shall only be through the Engineer, and that the agreement shall run for the duration of the Contract and can only be terminated by the Engineer.

C. Testing service personnel performing non-destructive examination (NDE) shall be certified as Level II or III for NDE methods in accordance with ASNT CP-189.

D. The testing service shall certify whether or not each weld meets the quality criteria immediately following its inspection, and shall indicate acceptance or rejection by marking the tested weld. Written reports shall be submitted to the Engineer within five working days of testing a weld. The Engineer will forward copies to the Contractor.

E. Unless otherwise allowed for by the Engineer, inspection and testing results of field rail welds shall be no further than 10 welds behind the production of welds.

3.14 WELD INSPECTION

A. Each weld shall be visually inspected to check for surface defects such as cracks and to determine conformance with the alignment and finishing tolerances herein.

1. Acceptance Criteria

a. Weld Quality, Paragraph 3.4

b. Alignment, Paragraph 3.8

c. Finishing, Paragraph 3.9

B. Inspection Procedures: The testing service shall prepare an inspection program for approval by the Engineer. The program shall include a description of proposed procedures, equipment and reports.

3.15 ULTRASONIC WELD TESTING

A. All field welds testing shall be ultrasonically tested (UT) over the entire cross section of the head, web and base. The UT equipment shall meet the requirements of AWS D1.1, Paragraph 6.17. The procedure shall meet the requirements of ASTM E 164. Prior to performing production UT of welds, all UT technicians shall demonstrate to the satisfaction of the Engineer that they can discern and identify indication produced by slag, porosity, lack of fusion, and cracks.

B. Testing Procedures: The testing service shall prepare a testing program for approval by the Engineer. The program shall include a description of the proposed procedures, materials, equipment, safety requirements and report.

C. Acceptance criteria shall be as follows:

1. Welds showing a response at any level that is identified as a crack or lack of fusion shall not be acceptable.

2. Welds showing a response that is less than 50% of the primary reference level shall be acceptable.

3. Welds showing a response greater than 50% but that do not exceed the primary reference level are acceptable, providing that all of the following apply:

    a. The defects are evaluated as slag or porosity.

    b. The largest defect does not exceed 0.180 inch in its largest dimension.

    c. The total area of the defects do not exceed 0.09 square inch.

    d. The sum of the greatest dimension of defects in a line does not exceed 3/8 inch.

4. Welds showing a response that exceeds the primary reference level shall not be acceptable.

D. Test Report: Each weld examined shall be recorded on a report form which includes as a minimum the following information:

1. Technique Sketch

2. Type of Equipment, Size of Transducer, Frequency, Angle

3. Calibration Data

4. Defect Description: Depth, Location, Size, Character

5. Equipment Identification: Serial Numbers

6. Name of Operator

7. Date of Inspection

3.16 MAGNETIC PARTICLE TESTING

A. All field welds shall be magnetic particle tested (MT). The magnetizing equipment shall be an electro-magnetic yoke meeting the following requirements:

1. DC lift capacity of 40 lbs. and/or

2. AC lift capacity of 10 lbs. at the maximum pole spacing.

3. The procedure shall meet the requirements of ASTM E 709.

4. All weld surfaces shall be tested except the underside of the rail base.

B. Testing Procedures: The testing service shall prepare a testing program for approval by the Engineer. The program shall include a description of the proposed procedures, materials, equipment, safety requirements and report.

C. Acceptance Criteria: The weld quality shall meet the requirements of Paragraph 3.4, above.

3.17 REWELDING

A. Welds rejected during inspection and/or testing shall be cut out and rewelded if possible or replaced with at least a 13' rail welded in its place in accordance with this Specification.

B. Minor defects may be repaired by qualified welders in accordance with repair procedures approved by the Engineer.

3.18 CLEANUP

A. Upon completion of each weld, the Contractor shall clean the Commuter Rail right-of-way of all welding debris, including discarded molds, slag, discarded equipment and any other debris that accumulated during the work.

END OF SECTION

SECTION 34 12 93

CRT – OTHER TRACK MATERIALS

PART I - GENERAL

1.1 SUMMARY

A. Description

1. This Section defines the requirements for the manufacture, testing, and supply of insulated joint bars, compromise joints, rail pads, shims, miscellaneous hardware for fastening of running rail, and special trackwork. All hardware shall be new and sized to match the fastener component for which they will be used.

B. Related Sections

1. Section 34 12 27 – Trackwork – Ballasted Track Construction
2. Section 34 12 34 – Standard and High Strength Rail
3. Section 34 12 45 – Trackwork – Field Rail Welding
4. Section 34 12 23 – Special Trackwork

1.2 REFERENCED STANDARDS

A. Insulated Joints and Compromise Joints

Sponsor	Number	Subject
AREMA	Chapter 4	Specifications for Bonded Insulated Rail Joints
AREMA	Chapter 4	Specifications for Quenched Carbon steel Joint Bars and Forged Compromise Joint Bars
ASTM	A490	Heat Treated Structural Steel Bolts, 150 ksi Minimum Tensile Strength
ASTM	A325	High-Strength Bolts for Structural Steel Joints
ISO	9003	Quality systems - Model for Quality Assurance in Final Inspection and Test

B. Rail Pads

1. High-density polyethylene rail pads shall be manufactured, tested, inspected, packaged and delivered in accordance with Pandrol Specification D-B Issue 2", and as modified herein.

C. Shims

Sponsor	Number	Subject
ASTM	A 653 M	Steel Sheet, Zinc-Coated by the Hot-Dip Process
CSA	G 40.21	Structural Quality Steels General Instruction
CSA	G 164	Hot-Dip Galvanized of Irregularly Shaped Objects
ISO	9003	Quality Systems - Model for Quality Assurance in Final Inspection and Test

D. Miscellaneous Hardware

Sponsor	Number	Subject
ASTM	B633	Electrodeposited Coatings of Zinc on Iron and Steel

1. Bolts and nuts shall conform to:

Sponsor	Number	Subject
AREMA	Chapter 4	Design for Track Bolts and Nuts Rail Drillings Bar Punchings and Track Bolts and Specifications for heat Treated Carbon Steel Track Bolts and Carbon Steel Nuts

2. Spring washers shall conform to:

Sponsor	Number	Subject
AREMA	Chapter 4	Specifications for Spring Washers

E. Buffer Stops

Sponsor	Number	Subject
ISO	9001	Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation and Servicing
AWS		Welded Steel Construction (Metal Arc Welding)

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein.

B. Submit or retain the following:

1. Insulated Bonded Joints and Compromise Joints.

   a. Submit detailed description of the adhesive to be used to bond the joint bars to the rail, and the method by which the quality of the adhesive formulation and preparation is regulated, maintained and monitored.

   b. Retain drawings showing details of bolts, lock nuts and all other components of the assembly, including fully detailed step-by-step installation instructions.

   c. Submit inspection and test plan.

   d. Retain packaging procedures.

   e. Retain most recent historical rolling load test records demonstrating adherence to these Specifications.

2. Rail Pads

   a. The Supplier’s drawings of injection molded or extruded rail pads shall be submitted prior to production of pads. The submittal and review of these drawings shall not in any way relieve the Contractor of complete responsibility for the design, manufacture and performance of the rail pads.

   b. Submit inspection and test procedures.

   c. Submit inspection and test plan.

   d. Retain packaging procedures.

3. Shims

   a. Submit inspection and Test Procedures

b. Submit inspection and Test Plan

c. Retain packaging Procedures

4. Miscellaneous Hardware

a. Retain shop drawings detailing the hardware to be furnished for the Work

b. Submit prequalification test results for review or prequalification test plans to include:

1) Test procedures

2) Schedule of qualification tests to be performed

3) Name of independent test laboratory proposed to perform tests

c. Retain production run test plans to include:

1) Test procedures

2) Test reporting procedures

d. Retain hardware manufacture quality assurance reports to include:

1) Production run test reports

2) Packaging procedures

1.4 QUALITY ASSURANCE

A. Quality assurance/quality control shall be in accordance with the requirements of the Quality Plan and the General Provisions, and Part III of this Section.

B. General

1. The Contractor shall include its inspection and testing plan for the work as part of its Quality Plan and the General Provisions. The inspection and testing plan shall identify who, what, when and where in the process of design, production, assembly, shipment and acceptance that all inspections will be performed.

C. The Contractor shall conduct review of fabrication drawings per the General Provisions, showing the details and procedures for the manufacture, cutting of the plates, machining of the inclined surfaces, drilling, punching or cutting of holes, and the finishing to specified tolerances prior to commencement of fabricated work.

1.5 ACCEPTANCE

A. Not Applicable.

PART II - PRODUCTS

2.1 MATERIALS

A. Insulated Bonded Joints and Compromise Joints

1. Insulated Joints

a. Joint bars for insulated bonded joints shall provide for full face contact, conforming to the shape of the designated RE rail section, and shall be fabricated from quenched carbon steel as specified in the AREMA specifications, except as defined herein. The joint bars shall be smooth and straight.

b. The finished height of the joint bars shall be within a tolerance of + 0 inches or - 1/32 inch of the dimensions defined in the AREMA specifications and the length of the joint bars shall be within +/- 1/8 inch of the standard length. The inside face of the joint bars shall be smooth, with no stamping or branding permitted.

c. Insulated bonded joints shall be complete with high pressure laminated end posts, steel core bushings, and heat-treated oval neck track bolts, nuts, and washers. Nuts shall be designed with a locking feature to prevent loosening meeting Contract requirements.

d. Adhesive and electrical insulation materials supplied with the joint bars shall have a shelf life of not less than one year when stored in a location protected from the weather, in tropical conditions in which the temperatures may vary from 600 F to 1100 F, at 95% relative humidity.

2. Compromise Joints

a. Compromise joint bars shall be of the size, shape, and punching pattern required to fit the rail sizes and sections being joined. Only factory designed and forged or cast compromise joint bars shall be used.

B. Rail Pads

1. Rail pads may be manufactured by injection molding or by the extrusion process, using raw materials which conform to the raw material supplier’s published data sheets.

2. Rail pads shall have a nominal thickness of 1/8 inch.

C. Shims

1. Regular and tapered steel shims used to adjust the elevation of the direct fixation fastener system shall be manufactured to the shape, size and configuration. The tapered shims shall be used to adjust rail cant transition from 1:20 to zero at the special trackwork areas and to maintain the required rail cant at grade crossings.

2. Steel shims specified to the thickness of 20 gauge and 11 gauge shall be manufactured from galvanized steel, coating designation G90, meeting the requirements of ASTM A653M, lock forming quality or approved equivalent.

3. Steel shims specified to the thicknesses of 1/8 inch, 3/8 inch, ½ and all tapered shims shall be manufactured from hot-rolled plate steel meeting the requirements of CSA G40.21, Grade 260 or equal. The measured thickness shall be inclusive of galvanizing. Steel shims shall be hot-dip galvanized in accordance with the latest edition of CSA G164, or equal. Galvanizing of shims shall consist of a minimum coating of 2 ounces/ft2 on each side after manufacture.

4. Steel shims shall be sheared or cut by a method to obtain the required configuration, and which is acceptable to the buyer. Edges sheared, punched or cut during manufacture shall be ground to remove all sharp edges. The ground edges shall be painted with cold galvanizing zinc-rich paint (GALVICON or equal). The paint shall be applied by manual brushing. Aerosol application shall not be acceptable. Slotted or circular holes shall be drilled, punched or cut at right angles to the shim surfaces.

5. Steel shims shall be smoothly finished and free from injurious warp and other surface imperfections due to projecting fins of metal caused by shearing, drilling or punching operations.

D. Miscellaneous Hardware

1. All miscellaneous hardware shall meet the physical dimensions, strength and properties and test requirements as defined herein.

2. The hex head bolts shall be used for embedding into concrete with or without epoxy grout and shall consist of the minimum dimensions required for the particular use.

3. The ultimate tensile strength of the hex head bolt itself shall equal or exceed the tensile strength of 56,380 pounds as specified in ASTM A325.

4. The hex head bolt shall be capable of withstanding the ultimate torque requirement necessary to destroy the diameter bolt as specified in ASTM A325.

PART III – EXECUTION

3.1 QUALIFICATION TESTING

A. Insulated Bonded Joints Bar

1. The Contractor shall provide certification from the manufacturer of prefabricated joints that the materials provided meet all material and performance requirements. Alternatively six (6) samples of the designated RE rail section will be prepared for qualification testing. Four (4) of the pieces shall be 24 inches long and two (2) of the pieces shall be 36 inches. All qualification testing will be performed at the expense of the Contractor.

a. End Hardening Tests

1) All six (6) samples shall be end hardened in accordance with the Contractor's submitted procedure. Two (2) sample ends shall be selected and tested as specified below:

i Brinell hardness readings will be taken at the centerline of the rail head longitudinally at ¼ inch intervals for a distance of one inch from the hardened end.

ii Acceptance shall be based on a Brinell hardness between 341 and 401 at all locations within ½ inch of the rail end. The hardness pattern shall decrease uniformly from the hardened end to the parent metal and the Brinell hardness measured at the points 1- 3/8 inches from the hardened end shall be greater than the Brinell hardness of the parent rail steel.

iii If either of the samples fails to meet the acceptance criteria, the procedure shall be modified and the tests repeated until acceptance hardness values have been achieved.

b. Bonded Joint Bar Test

1) Two bonded joints shall be completely assembled, by others, from the four sample pieces of RE rail each 2 feet long. The sample joints shall have a rail gap of 1/8 inch to allow determination of slippage of the rail joint. At the site, the joints shall be installed with a zero inch gap.

2) Each joint assembly shall then be sawn in half where the rails are butted together. The sawing shall be performed in a manner which will prevent overheating and damage to the epoxy bond, and the cut will be perpendicular to the centerline of the top of the rail with a tolerance of +/- one degree. A device shall be fabricated so that the reaction at the sawn end occurs only on the face of the joint bars when a load is applied at the centroid of the rail at the opposite end. Loads shall be applied longitudinally in increments of 25,000 pounds. Each load increment shall be maintained constant until the longitudinal deflection of the rail ceases before increasing the load to the next increment. The load will be increased in these designated increments until a total load of 500,000 pounds is attained, or failure occurs. At each increment of loading, the load and differential movement of the rail and joint bars, measured to 1/64 inch, shall be recorded.

3) The bonded joint shall be accepted based on the Longitudinal Compression Test when it is demonstrated that the joints have not slipped at any time during application of the incremental loads, up to 500,000 pounds, nor the magnitude of differential movement is 1/16 inch in any direction. At the completion of the test, after the load on the rail has been released, the relative position of the rail and joint bar shall be within 1/64 inch of its original position.

4) If either sample fails to meet the above-defined requirements, the installation procedure shall be modified and the tests repeated.

c. Stroke Rolling Load Test:

1) If historical loading test records of the Stroke Rolling Test are not available, one bonded joint shall be completely assembled, by others, from two sample pieces of RE rail each 3 feet long, in accordance with the Contractor's submitted procedure.

2) The bonded joint shall be mounted on a 30 inch stroke rolling load test machine and supported on 36 inch centers with the joint centered. The 50,000 pounds load on the rail shall be applied for 2 million cycles and the deflection of the rail at the centerline of rail shall be measured and recorded when the wheel load is over both points A and B for every 500,000 cycles and recorded to the nearest 1/128 inch.

3) Acceptance of the Stroke Rolling Load Test shall be based on evidence that no failure by bending has occurred after 2 million cycles of load application. At all times during the test the deflection of the bonded joints shall not exceed 1/16 inch.

4) If the sample fails to meet the above defined acceptance test requirements, the installation procedure shall be modified and the tests repeated.

3.2 RAIL PAD

A. Completed rail pads shall be clean, smooth and free of voids, sinking, gassing, laminations, cracks, burning and striations. Edges shall be well finished, and any sprue and flashes shall be cleanly cut off.

B. A certificate of conformity shall be presented for each batch of rail pads produced. Certificates of Conformity shall be included with the test reports previously referred to above.

3.3 SHIMS

A. Prototype Testing

1. Prototypes of each designated type of steel shim shall be manufactured, tested and supplied to the UTA for review and written statement of no objection provided prior to the start of production.

2. The prototype testing shall include checks of all dimensions, coating thickness, and surface finish for each type of shim specified.

B. Production Testing

1. The Contractor shall submit mill certificates defining the chemical and mechanical properties of the material supplied for the manufacture of the steel shims.

2. Dimensional measurements shall be performed by the Contractor to ensure conformance with the specifications. At least 2% of all the shims manufactured for the project and not less than 2 shim types manufactured per production day. Test results shall be submitted to the UTA for review.

3. The coating thickness of shims galvanized by the Contractor or its agent, shall be verified by the Contractor using magnetic gauges or by a procedure acceptable to UTA. Tests on the coating thicknesses shall be performed on at least 1% of all the shims produced for the project and on not less than 1 shim type per production day. Certified test results shall be submitted to the UTA for approval.

3.4 MISCELLANEOUS HARDWARE

A. Hardware Production Test Requirements

1. The Contractor shall submit mill certificates on the chemical and mechanical properties of the material supplied for the manufacture of the hardware.

2. The hex head bolts and lag screws shall be subjected to and meet the pre-qualification test acceptance criteria as specified in ASTM A325.

3. The hex head bolts and lag screws shall be subjected to and meet the production run test acceptance criteria as specified in ASTM A325.

B. Coating

1. All hex head bolts shall be coated in accordance with ASTM B633, Type II (Olive Drab) Fe/Zn.

2. All other designated hardware shall be galvanized in accordance with the applicable ASTM specifications.

3.5 PACKAGING, LABELING, AND STORAGE

A. Insulated Bonded Joint Bars and Compromise Joint Bars

1. Packaging

a. All materials used for packaging and crating for delivery shall be new, robust and of equal quality to the best commercial packaging and delivery crating practices accepted in the industry.

b. The choice of packaging shall be based on the most severe operational and climatic conditions expected during transit and storage. Key factors to be considered shall include the following:

1) Possibility of rough handling during transit and storage from manufacturer to final destination

2) Shock, vibrational and static impacts, and environmental exposure during loading, unloading and transit operations

3) Geographic and climatic conditions at the final destination

c. Handling facilities and practices used at points of loading and discharging of cargo.

2. Labeling

a. Each package unit shall be marked to identify contents, quantity, and gross weight.

B. Rail Pads

1. Completed rail pads shall be packaged in single PVC bags of 100 pieces each and packed in wooden crates of 4,000 pieces each for shipment to the designated site location.

C. Shims

1. Shims shall be packaged by the category of thickness, handled and stored in a manner that will prevent damage to the materials. The Contractor's commercial practice for preservation and packaging shall provide adequate protection against deterioration and physical damage during storage and handling.

2. Shipment marking information shall be provided on the interior and exterior of delivery containers. The information shall include nomenclature, manufacturer's name and part catalog number, contract or order number, and destination.

D. Miscellaneous Hardware

1. The hardware shall be manufactured, transported and stored so that no physical damage occurs to the threads. The hardware shall be packaged in equal quantities and in accordance with commercial practice for preservation and packaging.

2. Shipment marking information shall be provided on the exterior of delivery containers. The information shall include nomenclature, manufacturer's name and part catalog number, contract or order number, and destination. Each pallet shall not exceed 2000 pounds in weight and each pallet shall clearly show the quantities on each pallet.

END OF SECTION