

- DOCUMENT 000110 -

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- SECTION 024113 -

SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Removing above- and below-grade site improvements.
 - 2. Clearing and grubbing.
- B. Selective Demolition Schedule:
 - 1. Demolition and removal of existing site elements from Project site as indicated on Contract Drawings. Include, in general, the following:
 - a. Concrete and asphaltic paving, curbs and gutters, and as indicated on the Contract Drawings.
 - b. Turf and plants.
 - c. Utility structures including, but not limited to, pull boxes, irrigation piping, storm drain piping, fire hydrant.
 - d. Light fixtures.
 - e. Electrical conduits, wiring, and light poles not shown to be reused or protected in place.
 - f. Selected trees as indicated on the Contract Drawings.
 - 2. Remove and Salvage: Salvage existing items as indicated on the Contract Drawings. Remove from Project site and store as directed by Owner.
 - 3. Protect items to remain in place during construction.
- C. Referenced Sections:
 - 1. Section 013300 - Submittal Procedures.
 - 2. Section 015723 - Temporary Storm Water Pollution Control.
 - 3. Section 017419 - Construction Waste Management and Disposal.
 - 4. Section 017839 - Project Record Documents.
 - 5. Section 024119 - Selective Structure Demolition.
 - 6. Section 312300 - Earthwork: Site clearing.

1.02 REFERENCED STANDARDS

- A. California Building Standards Code (CBSC):
 - 1. California Building Code [CCR Title 24, Part 2] (CBC), 2013 edition:
 - a. Chapter 33 - Safeguards During Construction.
 - 1) Section 3302 - Construction Safeguards.
 - 2) Section 3303 - Demolition.
 - 2. California Fire Code [CCR Title 24, Part 9] (CFC), 2010 edition.
 - a. Chapter 14 - Fire Safety During Construction and Demolition.

3. California Green Building Standards Code (CALGreen Code) [CCR Title 24, Part 11] (CGC), 2013 edition.

1.03 DEFINITIONS

- A. *Clean*: To remove dirt clods, rocks, tree branches, and other items which may fall from hauling equipment or which may be "tracked" from the site.
- B. *Existing to Remain*: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the Architect, items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.
- C. *Remove*: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.
- D. *Remove and Reinstall or Relocate*: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or in locations indicated.
- E. *Remove and Salvage*: Items indicated to be removed and salvaged remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers with weather-resistant labels and deliver to Owner's designated secure onsite storage area.
- F. *Plant-Protection Zone*: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
- G. *Subsoil*: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- H. *Surface Soil*: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- I. *Topsoil*: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- J. *Tree-Protection Zone*: Area surrounding individual trees or groups of trees to be protected during construction, and as follows:
 - 1. As indicated on Drawings.
- K. *Vegetation*: Trees, shrubs, groundcovers, grass, and other plants.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Refer to Section 015639 for protection of trees and landscaping to remain.
- B. Coordination: Refer to Section 015723 for *erosion control* and compliance with the *Storm Water Pollution Prevention Plan*.

- C. Coordination: Refer to Section 017419 regarding procedures for implementing construction waste management requirements.
- D. Coordination: Refer to Section 024119 for selected demolition of buildings.
- E. Predemolition Conference: Prior to the work of this Section, visit the site in company with the Owner and Architect and verify the extent and location of demolition required.
 - 1. Identify limits of site demolition.
 - a. Mark items and interface surfaces, as required, to identify items to be removed and items to be left in place intact.
 - 2. Identify salvage items and agree upon disposition.
 - 3. Inspect and discuss condition of construction to be selectively demolished.
 - 4. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 5. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

1.05 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections, for information only, unless otherwise indicated.
 - 1. Proposed dust-control measures.
 - 2. Proposed noise-control measures.
- B. Schedule of selective demolition activities indicating the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
 - 2. Interruption of utility services.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Detailed sequence of selective demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
 - 6. Locations of temporary partitions and means of egress.
- C. Inventory of items to be removed by Owner.
- D. Inventory of items to be removed and salvaged by Contractor.
- E. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by selective demolition operations.
- F. Record Drawings: Provide at Project closeout according to Section 017839.
 - 1. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.

1.06 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Engage an experienced firm that has successfully completed selective demolition Work similar to that indicated for this Project.

1.07 FIELD CONDITIONS

- A. Existing Conditions: Conditions existing at time of inspection for bidding purpose will be maintained by Owner as much as practical.
 - 1. Utility Services:
 - a. Issue written notices of planned demolition operations to utility companies and pay associated fees.
 - b. Conduct demolition work without interrupting utilities to existing on-site facilities.
 - c. If necessary, maintain existing power poles and lines serving existing occupied buildings.
- B. Ambient Conditions:
 - 1. Dust Control:
 - a. Comply with dust regulations imposed by local air pollution agencies having jurisdiction. Prevent dust from becoming a nuisance to the public and to the surrounding area.
 - b. Use of water shall not result in hazardous or objectionable conditions, such as flooding or contaminated runoff.
 - 2. Erosion Control:
 - a. Comply with erosion and sediment regulations imposed by local agencies having jurisdiction.
- C. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- E. Prohibited Practices Within Protection Zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Storage or sale of removed items or materials on-site.
 - 3. Parking vehicles or equipment.
 - 4. Foot traffic.
 - 5. Erection of sheds or structures.
 - 6. Impoundment of water.
 - 7. Excavation or other digging unless otherwise indicated.
 - 8. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
 - 9. Do not direct vehicle or equipment exhaust towards protection zones.
 - 10. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
- F. Other Conditions:
 - 1. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.
 - 2. Do not commence site clearing operations until plant-protection measures are in place.

3. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

1.08 WARRANTY

- A. Existing Special Warranty: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with the requirements of CBC Chapter 33, as applicable.
- B. Comply with governing EPA notification regulations before starting selective site demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Waste Management: Comply with CALGreen Section 5.408 Construction Waste Reduction, Disposal and Recycling. Establish a construction waste management plan for the diverted material.
 1. Recycle or salvage for reuse a minimum of 50 percent of the non-hazardous construction and demolition waste in accordance with CALGreen 5.408.1.3.
 2. Reuse and recycle 100 percent of trees, stumps, rocks, and associated vegetation and soils resulting primarily from land clearing in accordance with CALGreen 5.408.3.
 3. Submit documentation to enforcing agency which demonstrates compliance with CALGreen 5.408.1.4. Sample compliance forms are available in the CALGreen Guide.

2.02 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
 1. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 2. Use materials whose installed performance equals or surpasses that of existing materials.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with the intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the Architect.

- E. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.02 PREPARATION

- A. Traffic:
 - 1. Provide and maintain adequate warning signs, lanterns, and lighting for vehicular and personnel protection during the period of work as required by applicable safety ordinances.
 - 2. During site clearing operations, ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.
 - 3. Do not close or obstruct walks or other occupied or used facilities without permission from the Owner and applicable municipal authorities for areas outside the Owner's property line.
 - 4. Provide required barriers and devices for SWPP.
 - a. Confirm Owner NOI has been submitted prior to starting work.
- B. Protection:
 - 1. Erect barriers, fences, guard rails, enclosures, and shoring to protect personnel, structures, the public, and site improvements and utilities to be maintained intact.
 - 2. Use appropriate means necessary to prevent dust from becoming a nuisance to the public and to the surrounding area. Use water in a manner which will not result in hazardous or objectionable conditions, such as flooding or contaminated runoff.
 - a. Comply with governing storm water runoff protection regulations.
 - 3. *Comply with regulations of the air quality management district in force at the time of the performance of this work.*
 - 4. Protect from damage trees and plants designated on Contract Drawings to remain.
 - 5. Protect existing site improvements to remain from damage during construction.
 - a. Restore damaged improvements to their original condition, as acceptable to Owner.
 - 6. Locate and clearly identify trees, shrubs, and other vegetation to remain.
 - a. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.
- C. Utility Services: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.
 - a. Provide not less than 72 hours' notice to Owner if shutdown of service is required during changeover.
 - 2. Arrange to shut off indicated utilities with utility companies.
 - 3. Where utility services are required to be removed, relocated, or abandoned, provide bypass connections to maintain continuity of service to other parts of the site before proceeding with selective demolition.

- D. Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.
- E. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
- F. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around selective demolition area.
 - 1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
 - 2. Protect existing site improvements, appurtenances, and landscaping to remain.
 - 3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.

3.03 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.04 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Arrange with utility companies and authorities having jurisdiction to shut off indicated utilities.
- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect and Owner not less than fourteen days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Owner's written permission.

- C. Excavate for and remove underground utilities indicated to be removed.

3.05 SITE DEMOLITION METHODS

- A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete Work within limitations of governing regulations and as follows:
 - 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 2. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
 - 3. Maintain adequate ventilation when using cutting torches.
 - 4. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 5. Dispose of demolished items and materials promptly. On-site storage or sale of removed items is prohibited.
 - 6. Return elements of construction and surfaces to remain to condition existing before start of selective demolition operations.
- B. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain, using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- C. Break up and remove concrete slabs on grade, unless otherwise shown to remain.
- D. Salvable Improvements: Carefully remove items indicated to be salvaged, and store on Owner's premises, unless otherwise indicated.

3.06 CLEARING AND GRUBBING

- A. Remove debris, foreign objects, concrete slabs and foundations, asphalt paving, portland concrete paving and curbs, site lighting and bases, site walls, area drains and catch basins, unwanted existing underground utilities and drain lines, conduits, trees, and other site construction as indicated and as required to provide a site suitable for constructing the proposed Project.
- B. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain.
 - 2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade, unless otherwise indicated.
 - 3. Use only hand methods for grubbing within protection zones.
 - 4. Chip removed tree branches and dispose of off-site.
- C. 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.

3.07 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials. Strip topsoil to depth indicated below:
 - 1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water and other erosion control measures.
 - 1. Limit height of topsoil stockpiles to 72 inches.
 - 2. Do not stockpile topsoil within plant protection zones.
 - 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.

3.08 ADJUSTING

- A. Promptly patch and repair holes and damaged surfaces caused to adjacent construction by selective demolition operations.

3.09 CLEANING

- A. Hose down and clean adjacent buildings and site on completion of selective demolition operation.
- B. Debris and Rubbish: Haul debris and materials promptly from site as they accumulate. Maintain site and adjacent public construction free of debris and sweep clean daily. Exercise all reasonable means to abate noise.
 - 1. Transport debris and materials to a legal off site disposal area in a manner that will prevent spillage on streets or adjacent areas. Clean up spillage from streets and adjacent areas.
 - 2. Do not store or burn refuse on site.
- C. Off-Site Work: *Clean* haul roads on and off site to a distance of 3 miles from the site, and as required by governing agencies having jurisdiction.
- D. Waste Management: Recycle or salvage waste materials in accordance with Section 017419.
- E. Change filters on air-handling equipment on Owner's adjacent buildings at completion of selective demolition operations.

3.10 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.
- B. Historical items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to the Owner, which may be encountered during selective demolition, remain the Owner's property.

Notify Owner immediately upon discovery. Do not disturb until direction is given. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to the Owner.

*1. Cooperate with Owner's archaeologist or historical adviser.

3.11 WASTE MANAGEMENT

- A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.
- D. 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.
- E. 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 024119 -

SELECTIVE STRUCTURE DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Demolition of portions of existing exterior and interior construction of building and removal from site or salvage, as required. Include, in general, the following:
 - 1. Removal of portions of existing structure incidental to the alteration of, and addition to, such structure as indicated on Contract Drawings.
 - 2. Protection of existing construction required to remain.
 - 3. Legal, off-site disposal of the products of demolition and associated debris.
 - 4. Identification for reuse or disposition of salvage, as specified or as indicated on Contract Drawings.
 - 5. Demolish specific items as indicated on Contract Drawings, including:
 - a. Portions of exterior and interior construction, except structural and other elements designated to remain.
 - b. Portions of plumbing fixtures, sprinklers, abandoned utility lines, HVAC equipment, and light fixtures.
 - c. Portions of concealed plumbing and gas lines to shut-off valves.
 - d. Portions of concealed electrical and telephone systems to be abandoned.
 - e. Portions of HVAC equipment and ductwork.
 - f. Concrete paving, vegetation, underground and exposed utilities.
- B. Referenced Documents and Sections:
 - 1. Section 011100 - Summary of Work.
 - 2. Section 013300 - Submittal Procedures.
 - 3. Section 017419 - Construction Waste Management and Disposal.
 - 4. Section 017329 - Cutting and Patching.
 - 5. ~~Section 070151 - Roofing Restoration.~~

1.02 REFERENCES

- A. California Building Standards Code (CBSC):
 - 1. California Building Code [CCR Title 24, Part 2] (CBC), 2013 edition:
 - a. Chapter 33 - Safeguards During Construction.
 - 1) Section 3302 - Construction Safeguards.
 - 2) Section 3303 - Demolition.
 - b. Chapter 34 - Existing Structures.
 - 1) Section 3403 - Additions, Alterations or Repairs.
 - 2. California Fire Code [CCR Title 24, Part 9] (CFC), 2013 edition.

- a. Chapter 14 - Fire Safety During Construction and Demolition.
- B. National Fire Protection Association (NFPA):
 - 1. 241 - Safeguarding Building Construction and Demolition Operations.
- C. National Institute of Building Standards (NIBS):
 - 1. Asbestos Abatement and Management in Buildings - Model Guide Specifications, 1988.
- D. Occupational Safety and Health Standards for the Construction Industry (29 CFR Part 1926) as promulgated by OSHA (Subpart 7 - Demolition).
- E. Resilient Floor Covering Institute (RFCI):
 - 1. WP - Recommended Work Practices for Removal of Resilient Floor Coverings, including Addendum.
- F. United States Green Building Council (USGBC):
 - 1. Leadership in Energy and Environmental Design (LEED):
 - a. Green Building Rating System.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with construction waste management requirements specified in Section 017419.
- B. Predemolition Conference: Prior to the work of this Section, visit the site in company with the Owner and Architect and verify the extent and location of demolition required.
 - 1. Verify that structures where demolition work is located are unoccupied and discontinued in use.
 - 2. Identify limits of demolition.
 - a. Mark items and interface surfaces, as required, to identify items to be removed and items to be left in place intact.
 - 3. Identify salvage items and agree upon disposition.
 - 4. Inspect and discuss condition of construction to be selectively demolished.
 - 5. Review structural load limitations of existing structure.
 - 6. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 7. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

1.04 SUBMITTALS

- A. Procedures: Prior to the commencement of the work of this Section, and in accordance with the provisions of Section 013300, submit detailed sequence of proposed salvage, demolition, and removal procedures to the Architect for review before work is started. Procedures shall include:
 - 1. List of items to be removed.
 - 2. In consultation with the Owner, identify items to be removed to salvage, and receive Owner's directions relative to the disposition of such salvage.
 - 3. Proposal for coordination with other work in progress.
 - 4. Disconnection schedule of utility services.

5. Detailed description of methods and equipment to be used for each operation.
6. Sequence of operations.
7. Safety procedures regarding demolition work in general, and demolition work adjacent to occupied facilities and public ways in particular.
8. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.
9. Predemolition Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Submit before Work begins.
10. Refer to Section 011100 for scheduling of work during ongoing activities.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. Demolition Firm Qualifications: An experienced firm licensed as a demolition Contractor under State of California law which has specialized in demolition work similar in material and extent to that indicated for this Project.
 2. Personnel Qualifications: Regularly engaged and specializing, for the preceding 5 years, in demolition work.
 - a. Adequately equipped to provide expeditious removal from the site of refuse resulting from demolition operations.

1.06 FIELD CONDITIONS

- A. Ambient Conditions:
 1. Dust Control:
 - a. Take affirmative action to prevent dust from becoming a nuisance to the occupants, neighbors, the public, and to other work being performed on or near the site.
 - b. Comply with dust regulations imposed by local air pollution agencies having jurisdiction. Prevent dust from becoming a nuisance to the public and to the surrounding area.
 - c. Use of water shall not result in hazardous or objectionable conditions, such as flooding or contaminated runoff.
 - d. Comply with dust regulations imposed by local air pollution agencies having jurisdiction.
 2. Erosion Control:
 - a. Comply with erosion and sediment regulations imposed by local agencies having jurisdiction.
- B. Existing Conditions:
 1. Utility Services:
 - a. Conduct demolition work without interrupting utilities to temporary on-site facilities.
 - b. Issue written notices of planned demolition operations to utility companies and pay associated fees.
 - c. If necessary, maintain existing power lines serving existing occupied buildings.

2. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - a. Hazardous materials will be removed by Owner before start of the Work.
3. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Contractor, Owner, and Architect.
 - a. Hazardous materials will be removed by Owner under a separate contract.

1.07 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.
 1. If possible, retain original installer or fabricator to patch the exposed. If it is impossible to engage original Installer or fabricator, engage another recognized experienced and specialized firm.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Regulatory Requirements:
 1. Obtain and pay for permits required in connection with the work of this Section. Pay fees made necessary by the removal and dumping of debris.
 2. Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
 3. Standards: Comply with ANSI A10.6 and NFPA 241.
 4. Conform to the requirements of NFPA 241 with regard to early planning, scheduling, and implementation of fire prevention measures, fire protection systems, rapid communications, and on-site security.

2.02 SYSTEM DESCRIPTION

- A. Sustainability Requirements: Comply with waste management procedures of Section 017419.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to work of this Section, verify that structure has been examined for asbestos containing products, and that abatement procedures have been completed by Owner in compliance with NIBS Model Guide Specifications and applicable local codes.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate

and measure the nature and extent of conflict. Promptly submit a written report to Architect.

- E. Engage a State of California registered engineer to 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 operations.
- F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities. If hazards to persons or property are anticipated, take all necessary measures to prevent or minimize such hazards.

3.02 PREPARATION

- A. Protection:
 - 1. Erect barriers, fences, guard rails, enclosures, chutes, and shoring to protect personnel, structures, and utilities remaining intact.
 - a. Install temporary construction fences to prevent public access to areas of demolition activities.
 - 2. Provide temporary covers and protect existing buildings and other existing work that is to remain in place, that is to be reused, or that is to remain the property of the Owner, by temporary covers, shoring, bracing, and supports.
 - 3. Warning Signs: Provide warning signs, lanterns, and lighting for vehicular and pedestrian protection. Maintain warning signs during the period of work as required by applicable safety ordinances.
 - 4. Where required, shut off, cap, and otherwise protect existing utility lines in accordance with the requirements of the public agencies or utilities having jurisdiction.
 - 5. Install erosion control measures, as required and as indicated on the Contract Drawings.
- B. Traffic Access:
 - 1. Conduct demolition activities in a manner that minimizes interference with roads, streets, driveways, sidewalks, and adjacent facilities.
 - 2. Obtain permission from authorities having jurisdiction before closing or obstructing streets, sidewalks, alleys, or passageways.
 - 3. If required by governing authorities, provide alternate routes around closed or obstructed traffic ways.
 - 4. Maintain access to adjacent existing building entrances and exits to ensure uninterrupted operations during demolition work.

3.03 UTILITY SERVICES

- A. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.
- B. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.
- C. Provide at least 72 hours' notice to Owner if shutdown of service is required during changeover.

- D. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated utilities when requested by Contractor.
 - 2. Arrange to shut off indicated utilities with utility companies.
 - 3. If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition, provide temporary utilities that bypass area of selective demolition and that maintain continuity of service to other parts of building.
 - 4. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
- E. Utility Requirements: Refer to Division 33 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.04 DEMOLITION METHODS

- A. General:
 - 1. Use only methods and equipment approved by governmental agencies having jurisdiction. Demolish and completely remove from job site the existing construction designated to be removed.
 - 2. Where site construction is designated for demolition, remove underground portions, including roots by grinding stumps to 3 feet below new grade.
- B. Utilities and Related Equipment: Where required, remove existing utilities as indicated and as uncovered by work, and terminate in a manner conforming to Code. Salvage meters and related equipment without additional cost to the Owner. Dispose of abandoned utility lines encountered that are not shown on the Contract Drawings.
- C. Trees: Protect trees and landscaping within the project site that might be damaged during demolition operations. Restore landscaping scarred or damaged by Contractor equipment or operations to their original condition or replace as determined by the Architect. Restoration procedures will be subject to the Architect's acceptance-review prior to initiation.

3.05 SELECTIVE DEMOLITION

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and

- chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
 5. Maintain adequate ventilation when using cutting torches.
 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 9. Dispose of demolished items and materials promptly.
 10. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.
- B. Removed Items for Salvage: Comply with the following:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner indicated on Contract Drawings.
 5. Protect items from damage during transport and storage.
- C. Removed Items for Reinstallation: Comply with the following:
1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
- E. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.

- F. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
- G. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.
- H. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI-WP and its Addendum.
 - 1. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.
- ~~I. Roofing: Protect roofing surfaces around roof-mounted mechanical equipment during removal activities. Maintain waterproofing of roof areas at all time to prevent damage to interior spaces. Refer to Section 070151 for roofing repairs.~~
- I. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

3.06 PATCHING AND REPAIRS

- A. General: Promptly repair damage to adjacent construction caused by selective demolition operations.
- B. Repairs: Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials. Comply with Section 017329.
 - 1. Completely fill holes and depressions in existing masonry walls that are to remain with an approved masonry patching material applied according to manufacturer's written recommendations.
- C. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.
- D. Floors and Walls: Where walls or partitions that are demolished extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - 1. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
 - 2. Where patching occurs in a painted surface, apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
 - 3. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

3.07 SALVAGE

- A. Demolition: Materials or equipment to be demolished shall become the property of the Contractor, except for items specified to remain the

property of the Owner. Such salvage items shall be carefully removed to avoid damage and be delivered by the Contractor to location stipulated.

1. Materials and equipment shall not be placed on view to prospective purchasers or sold on site.
- B. Replacement: In the event of demolition of items not scheduled to be demolished, promptly replace such items to the acceptance of the Architect and at no additional cost to the Owner.

3.08 CLEANING

- A. Debris and Rubbish: Remove and transport debris and rubbish to an off-site disposal area via a haul route approved by the governing agency in a manner that will prevent spillage on streets or adjacent areas. Clean up spillage from streets and adjacent areas.
- B. Do not store or burn materials on site.
- C. Remove all tools, equipment, and appliances used for demolition from the site upon completion of the work.

END OF SECTION

- SECTION 031000 -

CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Formwork for cast-in place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

1.02 RELATED REQUIREMENTS

- A. Section 03 2000 - Concrete Reinforcing.
- B. Section 03 3000 - Cast-in-Place Concrete.
- C. ~~Section 03 3523 - Exposed Aggregate Concrete Finishing.~~ [Not used.](#)
- D. Section 05 1200 - Structural Steel: Placement of embedded steel anchors and plates in cast-in-place concrete.

1.03 REFERENCE STANDARDS

- A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; 2010.
- B. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute; 2010.
- C. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute; 2011.
- D. ACI 347 - Guide to Formwork for Concrete; American Concrete Institute; 2004.
- E. ASME A17.1 - Safety Code for Elevators and Escalators; The American Society of Mechanical Engineers; 2007 with 2008 Addendum.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on void form materials and installation requirements.
- C. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver prefabricated forms and installation instructions in manufacturer's packaging.
- B. Store prefabricated forms off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 - PRODUCTS

2.01 FORMWORK - GENERAL

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- B. Design and construct to provide resultant concrete that conforms to design with respect to shape, lines, and dimensions.
- C. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.

2.02 WOOD FORM MATERIALS

- A. Form Materials: At the discretion of the Contractor.

2.03 FORMWORK ACCESSORIES

- A. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
 - 1. Composition: Colorless reactive, mineral oil-based, soy-based, or vegetable-oil based compound.
- B. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
- C. Embedded Anchor Shapes, Plates, Angles and Bars: As specified in Section 05 1200.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

- A. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

3.03 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

3.04 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items that will be cast directly into concrete.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Install waterstops in accordance with manufacturer's instructions, so they are continuous without displacing reinforcement. Heat seal joints so they are watertight.

3.06 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI 117, unless otherwise indicated.

3.07 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

END OF SECTION

- SECTION 033000 -

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Floors and slabs on grade.
- B. Concrete shear walls, elevator shaft walls, and building walls.
- C. Concrete footings and foundation walls.
- D. Concrete curbs.
- E. Joint devices associated with concrete work.
- F. Miscellaneous concrete elements, including equipment pads, light pole bases, flagpole bases, thrust blocks, and manholes.
- G. Concrete curing.

1.02 RELATED REQUIREMENTS

- A. Section 03 1000 - Concrete Forming and Accessories: Forms and accessories for formwork.
- B. Section 03 2000 - Concrete Reinforcing.
- ~~C. Section 03 3511 - Concrete Floor Finishes: Densifiers, hardeners, applied coatings, and polishing.~~
- ~~D. Section 07 9513 - Expansion Joint Cover Assemblies.~~
- E. Section 07 9005 - Joint Sealers: Sealants for saw cut joints and isolation joints in slabs.
- F. Section 32 1313 - Concrete Paving: Sidewalks, curbs and gutters.

1.03 REFERENCE STANDARDS

- A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; American Concrete Institute International; 2010.
- B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2002).
- C. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete; American Concrete Institute International; 1998 (Reapproved 2004).

- D. ACI 301 - Specifications for Structural Concrete; American Concrete Institute International; 2010.
- E. ACI 302.1R - Guide for Concrete Floor and Slab Construction; American Concrete Institute International; 2004 (Errata 2007).
- F. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.
- G. ACI 305R - Hot Weather Concreting; American Concrete Institute International; 2010.
- H. ACI 306R - Cold Weather Concreting; American Concrete Institute International; 2010.
- I. ACI 308R - Guide to Curing Concrete; American Concrete Institute International; 2001 (Reapproved 2008).
- J. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2011.
- K. ACI 347 - Guide to Formwork for Concrete; American Concrete Institute International; 2004.
- L. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2003.
- M. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2012a.
- N. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens); 2013.
- O. ASTM C150/C150M - Standard Specification for Portland Cement; 2007.
- P. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a.
- Q. ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete; 2005.
- R. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2013.
- S. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2008a.
- T. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2011.
- U. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2013.
- V. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete; 2010.
- W. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2013.
- X. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures; 2011.

- Y. ASTM E1155 - Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers; 1996 (Reapproved 2008).
- Z. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2011.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
- C. Mix Design: Submit proposed concrete mix design.
 - 1. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 - Concrete Quality, Mixing and Placing.
- D. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.
- E. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
 - 1. Maintain one copy of each document on site.
- B. Follow recommendations of ACI 305R when concreting during hot weather.
- C. Follow recommendations of ACI 306R when concreting during cold weather.

PART 2 - PRODUCTS

2.01 FORMWORK

- A. Comply with requirements of Section 03 1000.

2.02 REINFORCEMENT

- A. Comply with requirements of Section 03 2000.

2.03 CONCRETE MATERIALS

- A. Cement: ASTM C150, II / V Portland type. unless noted otherwise on drawings.
 - 1. Acquire all cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C 33.
 - 1. Acquire all aggregates for entire project from same source.
- C. Lightweight Aggregate: ASTM C330/C330M.
- D. Fly Ash: ASTM C618, Class F.
- E. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.
- F. Water: Clean and not detrimental to concrete.

- G. Fiber Reinforcement: Alkali-resistant polypropylene complying with ASTM C1116/C1116M.
 - 1. Fiber Length: 0.75 inch, nominal.
 - 2. Products:
 - a. Forta Corporation; FORTA-FERRO: www.forta-ferro.com.
 - b. Euclid Chemical Company, an RPM company, Fiberstrand 150.
 - c. Grace Construction Products, W.R. Grace & Co., Grace MicroFiber..
 - d. Substitutions: See Section 01 6000 - Product Requirements.

2.04 ADMIXTURES

- A. Chemical Admixture Manufacturers:
 - 1. Anti-Hydro Co., Inc.,
 - 2. Euclid Chemical Co.,
 - 3. Master Builders Technology, Inc.,
 - 4. W.R. Meadows, Inc.,
 - 5. Sika Corporation,
- B. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- C. Air Entrainment Admixture: ASTM C260/C260M.
 - 1. Products:
 - a. Air-Mix or Perma-Air by Euclid Chemical Co.
 - b. MB-VR or Micro-Air by Master Builders Technology, Inc.
 - c. Sealtight AEA by W.R. Meadows, Inc.
 - d. Sika AER by Sika Corporation.
- D. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
 - 1. Products:
 - a. Super P by Anti-Hydro Co., Inc.
 - b. Eucon 37 by Euclid Chemical Co.
 - c. Rheobuild or Poly heed by Master Builders Technology, Inc.
 - d. Sikament 300 by Sika Corporation
- E. Water Reducing and Accelerating Admixture: ASTM C494/C494M Type E.
 - 1. Products:
 - a. Accelguard 80 by Euclid Chemical Co.
 - b. Pozzutec 20 by Master Builders Technology, Inc.
- F. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.
 - 1. Products:
 - a. Eucon Retarder 75 by Euclid Chemical Co.
 - b. Pozzolith R by Master Builders Technology, Inc.
 - c. Plastiment by Sika Corporation.
- G. Accelerating Admixture: ASTM C494/C494M Type C.
- H. Retarding Admixture: ASTM C494/C494M Type B.

- I. Water Reducing Admixture: ASTM C494/C494M Type A.
 1. Products:
 - a. Eucon WR-75 by Euclid Chemical Co.
 - b. Poly heed by Master Builders Technology, Inc.
 - c. Plastocrete 161 by Sika Corporation.

2.05 ACCESSORY MATERIALS

- A. Underslab Vapor Retarder: Multi-layer, fabric-, cord-, grid-, or aluminum-reinforced polyethylene or equivalent, complying with ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. The use of single ply polyethylene is prohibited.
 1. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations in vapor retarder.
 2. Products:
 - a. Insulation Solutions, Inc; Viper VaporCheck II 15-mil (Class A): www.insulationsolutions.com.
 - b. Stego Industries, LLC; Stego Wrap Vapor Barrier 15-mil (Class A): www.stegoindustries.com.
 - c. W.R. Meadows, Inc.; PERMINATOR Class A - 15 mils: www.wrmeadows.com.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- B. Non-Shrink Cementitious Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
 1. Minimum Compressive Strength at 28 Days, ASTM C109/C109M: 8000 psi.

2.06 BONDING AND JOINTING PRODUCTS

- A. Epoxy Bonding System: Complying with ASTM C881/C881M and of Type required for specific application.
 1. Products:
 - a. W.R. Meadows, Inc.; Rezi-Weld Gel Paste, Rezi-Weld Gel Paste State, Rezi-Weld 1000, or Rezi-Weld 1000 State: www.wrmeadows.com.
- B. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
- C. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with minimum 1 inch diameter holes for conduit or rebars to pass through at 6 inches on center; ribbed steel stakes for setting.

2.07 CURING MATERIALS

- A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.

- B. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound, that dissipates within 3 to 5 weeks; complying with ASTM C309.

2.08 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer.
- D. Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions.
- E. Normal Weight Concrete:
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: As indicated on drawings.
 - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 - 3. Water-Cement Ratio: Maximum 50 percent by weight.
 - 4. Total Air Content: 4 percent, determined in accordance with ASTM C173/C173M.
 - 5. Maximum Slump: 4 inches. before addition of plasticizing admixture.
 - 6. Maximum Aggregate Size: 1 1/2 inch.
- F. Structural Lightweight Concrete:
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: As indicated on drawings.
 - 2. Water-Cement Ratio: Maximum 45 percent by weight.
 - 3. Total Air Content: 3 percent, determined in accordance with ASTM C173/C173M.
 - 4. Maximum Slump: 4 inches.
 - 5. Maximum Aggregate Size: 3/4 inch.
 - 6. Maximum dry unit weight: 105 lb per cubic foot.

2.09 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
 - 1. Colored Concrete: Add pigments in strict accordance with manufacturer's instructions to achieve consistent color from batch to batch.
 - 2. Fiber Reinforcement: Batch and mix as recommended by manufacturer for specific project conditions.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.
 - 1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
- B. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.

3.02 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Notify Architect not less than 24 hours prior to commencement of placement operations.
- D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- E. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- F. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.
- G. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.
- H. SLAB JOINTING
 - 1. Locate joints as indicated on the drawings.
 - 2. Anchor joint fillers and devices to prevent movement during concrete placement.
 - 3. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
- I. FLOOR FLATNESS AND LEVELNESS TOLERANCES
 - 1. Measure F(F) and F(L) in accordance with ASTM E1155, within 48 hours after slab installation; report both composite overall values and local values for each measured section.
 - 2. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.
- J. CONCRETE FINISHING

K. CURING AND PROTECTION

1. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, 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.
3. Surfaces Not in Contact with Forms:
 - a. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
 - b. Final Curing: Begin after initial curing but before surface is dry.

L. DEFECTIVE CONCRETE

1. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
2. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
3. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

M. PROTECTION

1. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION

- SECTION 051200 -

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Structural steel framing members, support members.
- B. Base plates, shear stud connectors and expansion joint plates.
- C. Grouting under base plates.

1.02 RELATED REQUIREMENTS

- A. Section 01 4000 - Quality Control; for independent testing agency procedures and administrative requirements.
- B. Section 01 3000 - Submittals Procedures.
- C. Division 3 Section "Cast-In-Place Concrete" for setting of anchor bolts, concrete foundations, and for as-built survey of concrete work.
- D. Division 5 Section "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other metal items not defined as structural steel.
- ~~E. Section 05 1214 - Architecturally Exposed Structural Steel (AESS)~~
- F. Section 05 5000 - Metal Fabrications: Steel fabrications affecting structural steel work.
- G. Division 9 painting Sections for surface preparation and priming requirements.

1.03 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION:

- A. Anchors for casting into concrete.
- B. Loose bearing plates to receive Structural Steel.

1.04 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.
- B. Architecturally Exposed Structural Steel: Structural steel designated as architecturally exposed structural steel in the Contract Documents, or exposed to public view.

1.05 REFERENCE STANDARDS

- A. AISC (MAN) - Steel Construction Manual; American Institute of Steel Construction, Inc.; 2010.
- B. AISC S303 - Code of Standard Practice for Steel Buildings and Bridges; American Institute of Steel Construction, Inc.; 2005.
- C. AISC S348 - Specification for Structural Joints Using ASTM A325 or A490 Bolts; 2004.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2005.
- E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- F. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished; 2007.
- G. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2005.
- H. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength; 2004e01.
- I. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2010.
- J. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2009.
- K. ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat-Treated, 150 ksi Minimum Tensile Strength; 2012.
- L. ASTM A490M - Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric); 2012.
- M. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2010a.
- N. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts; 2007a.
- O. ASTM A563M - Standard Specification for Carbon and Alloy Steel Nuts [Metric]; 2007.
- P. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel; 2007.
- Q. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2006a.
- R. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2004.
- S. ASTM E164 - Standard Practice for Ultrasonic Contact Examination of Weldments; 2008.
- T. ASTM E709 - Standard Guide for Magnetic Particle Testing; 2008.
- U. ASTM F436 - Standard Specification for Hardened Steel Washers; 2011.

- V. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners; 2009.
- W. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2007a.
- X. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2007.
- Y. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2010.

1.06 SUBMITTALS

- A. Product Data:
 - 1. Producer's or Manufacturer's Specifications recommended installation instructions, laboratory test reports and other data required to prove compliance with the specified requirements.
 - a. Structural steel including chemical and physical properties.
 - b. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - c. Shop primers.
 - 2. Nonshrink grout.
- B. Shop Drawings: Show complete details and schedules for fabrication of structural steel components and shop assembly of members.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Provide setting drawings, templates and directions for installing anchor bolts and other embedded structural steel.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
 - 5. Identify shop drawing details by reference to Sheet and Detail Number on the Contract Drawings.
 - 6. Submit erection plan sequence and procedures.
- C. Welding certificates: Submit Certificates certifying welders employed on the work verifying AWS qualifications within the previous 12 months.
- D. Qualification Data: For Installer, fabricator, professional engineer, and testing agency.
- E. Manufacturer's Mill Certificate: Submittal shall certify that products meet or exceed specified requirements.
- F. Mill Test Reports: Submit manufacturer's certificates indicating structural strength, destructive and non-destructive test analysis.
- G. Test Reports: Submit reports of tests conducted on shop and field welded and bolted connections, including data on type of tests conducted and test results.
- H. Shop and Field inspection is required.

- I. Submit material cost data for all materials required to construct the work in place. The cost data should be marked up to the General Contractor. If the work is self performed the material cost shall reflect the actual cost of the material without mark up.
- J. Provide manufacturer's information/data sheet or a letter from the manufacturer indicated the location of manufacture, amount of recycled content (post consumer and post industrial percentage) in the product, and the location of raw material harvest if within 500 miles of the project site.

1.07 FIELD MEASUREMENTS

- A. Verify that field measurements, lines, grades and elevations agree with measurements shown on the Contract Drawings. Concrete Contractor shall furnish the Steel Contractor accurate as-built drawing of bolt settings.
- B. Contractor shall be entirely responsible for the correctness, conformity, accuracy and execution of structural steel work.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CASE or CSE [or be certified by IAS AC 172](#).
- B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Cbd or Sbd [or be certified by IAS AC 172](#).
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1, P2, P3 or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- E. Comply with applicable provisions of the following specifications and documents:
 1. 2013 California Building Code, Title 24.
 2. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - a. Paragraph 4.2.1 of the above code is hereby modified by deletion of the following sentence:
 - 1) "This approval constitutes the owner's acceptance of all responsibility for the design adequacy of any detail configuration of connections developed by the fabricator as part of his preparation of these shop drawings."
 - b. Paragraph 4.2.2 is deleted in its entirety.
 - c. Paragraph 7.9.3 of the above code is hereby modified by the deletion of the following sentence:
 - 1) "The contract documents specify the sequence of schedule of placement of such elements."
 3. American Welding Society "Code D1-1 Structural Welding Code".
 4. A.I.S.C. Specifications for Design, Fabrication and Erection of Structural Steel for Buildings.
 5. R.C.R.B.S.J. Specifications for "Structural Joints Using ASTM A325 Bolts".

- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
- G. Fabricate structural steel members in accordance with AISC "Steel Construction Manual."

1.09 REGULATORY REQUIREMENTS

- A. Comply with applicable provisions of the following building codes, including special inspection provisions:
 - 1. California Building Code (CBC), Chapter 17A and 22A.
- B. Comply with applicable provisions of the following specifications and documents as modified by the building codes:
 - 1. AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," except as follows.
 - a. Modify paragraph 4.2.1 by deletion of the sentence: "This approval constitutes the Owner's acceptance of all responsibility for the design adequacy of any connections designed by the fabricator as part of his preparation of these shop drawings."
 - b. Modify paragraph 7.9.3 by deletion of the sentence: "The contract documents specify the sequence and construction of placement of such elements."
 - 2. AISC 341 and AISC 341s1, "Seismic Provisions for Structural Steel Buildings" and Supplement No. 1.
 - 3. AISC 360, "Specification for Structural Steel Buildings," including high-seismic applications.
 - 4. AWS D1.1/D1.1M, "Structural Welding Code-Steel".
 - 5. AWS D1.8/D1.8, "Structural Welding Code-Seismic Supplement".
 - 6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."Steel Structures Painting Council.
 - 7. SSPC, "Steel Structures Painting Manual, Volume 2, Systems and Specifications".

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 erosion and deterioration.
- B. Deliver materials, structural steel and components to the job site properly marked to identify location for which they are intended. Use markings corresponding to markings shown on the approved shop drawings.
- C. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
- D. 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.

1.11 COORDINATION

- A. Furnish 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.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Steel W Shapes and Tees: ASTM A992/A992M.
- B. Channels, Angles, M-shapes, S-Shapes: ASTM A 36.
- C. Plate and Bar: ASTM A 36, or ASTM A 572, Grade 50 where indicated on Contract Drawings.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- E. Steel Pipe: ASTM A 53, Type E or S, Grade B welded seamless pipe, Standard weight class or as indicated on Contract Drawings, Black finish except where indicated to be galvanized.
- F. Welding Electrodes: Comply with AWS requirements.
- G. Shear Stud Connectors: Made from ASTM A 108 Grade 1015 bars.
- H. High-Strength Structural Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M). 3, weathering steel.
- I. High-Strength Structural Bolts: ASTM A490 (ASTM A490M), with matching ASTM A563 (ASTM A563M) nuts and ASTM F436 washers; Type 3 weathering steel.
- J. Grout: Non-shrink, non-metallic aggregate type, complying with ASTM C1107/C1107M and capable of developing a minimum compressive strength of 6000 psi at 28 days.

2.02 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M) or ASTM A 490 as indicated, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish, except all components exposed to the weather shall be hot-dipped galvanized.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type, finish to match bolts. Provide mechanically deposited zinc coating with baked epoxy-coated finish where exposed to the weather.

- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers with plain finish, except all components exposed to the weather shall be hot-dipped galvanized.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type, finish to match bolts.
- C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- D. Unheaded Anchor Rods: ASTM F 1554, Grade 105.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel, Type DH.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
 - 5. Finish: Plain.
- E. Headed Anchor Rods: ASTM A 307, Grade A, straight.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel, Type DH.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
 - 5. Finish: Plain.
- F. Threaded Rods: ASTM F 1554, Grade 36, 55, 105, or as indicated on Contract Documents.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel, Type DH.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
 - 5. Finish: Plain.
- G. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.
- H. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.
- I. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

- J. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable substituted product by one of the following:
 - a. Amscot Structural Products Corp.
 - b. Fluorocarbon Company Limited.
 - c. R.J. Watson Bridge & Structural Engineered Systems.
 - d. Seismic Energy Products, L.P.
 - 2. Mating Surfaces: PTFE and PTFE.
 - 3. Coefficient of Friction: Not more than 0.10.
 - 4. Design Load: Not less than 6,000 psi (41 MPa).
 - 5. Total Movement Capability: 2 inches (50 mm).

2.03 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.
- B. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.04 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. Grout shall have a minimum compressive strength of not less than 8000 psi in 28 days, or as indicated on Contract Drawings.

2.05 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Load and Resistance Factor Design Specification for Structural Steel Buildings."
 - 1. Camber structural-steel members where indicated.
 - 2. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
 - 3. Mark and match-mark materials for field assembly.
 - 4. 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.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning or SSPC-SP 3, "Power Tool Cleaning."
- F. 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 and manufacturer's written instructions.
- G. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Base-Plate 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.
- H. Bases and Bearing Plates: Shop weld to columns and members attached to concrete.

2.06 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 - 1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
 - 3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.07 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 to be high-strength bolted with slip-critical connections.
 - 4. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to SSPC-SP 2, "Hand Tool Cleaning," or SSPC-SP 3, "Power Tool Cleaning."

- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Prime paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Apply a 1-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

2.08 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.
 - 1. Fill vent holes and grind smooth after galvanizing.
 - 2. Galvanize structural steel members as indicated on Contract Drawings. Provide minimum 1.25 oz/sq.ft. galvanized coating.

2.09 SOURCE QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
 - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Conform to the inspection requirements of CBC Chapter 17A and the testing requirements of CBC 2212.
 - 1. Inspection of Shop Fabrication: CBC 1704A.3
 - a. Inspection of shop fabrication shall be required for significant structural detailed connection and fabrication work as directed by the enforcement agency. This inspection shall be made by a qualified inspector approved by the enforcement agency. The inspector shall furnish the Architect, Structural Engineer and the enforcement agency with a report that the materials and workmanship conform to the approved plans and specifications.
- C. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- D. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- E. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3. Ultrasonic Inspection: ASTM E 164.
 - 4. Radiographic Inspection: ASTM E 94.

- F. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
 - 1. Bend tests will be performed if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.
- G. Visual Inspection of Seam Welds at Inside and Outside of HSS products in accordance with DSA Bulletin 17-03.
 - 1. Review manufacturer's Material Test Report (MTR). Verify that material properties are as specified by DSA-approved documents, and that materials are readily identifiable and traceable to a MTR.
 - 2. Sample unidentifiable material for testing. Testing of materials must be performed by a laboratory accepted in the DSA Laboratory Evaluation and Acceptance Program (LEA).
 - 3. Conduct a thorough visual examination of the seam weld area in hollow structural sections (HSS) for visible discontinuities. Visual examination shall include as a minimum the exterior of the seam weld and the interior at each end.
 - 4. Conduct a thorough visual examination of surfaces of structural plate for visible lamination discontinuities.
- H. Determine mechanical properties in conformance with ASTM A 370 of the following materials:
 - 1. Structural steel shapes and tubing.
 - 2. Anchor bolts.
 - 3. Filler metals for welding.
 - 4. High-strength threaded fasteners.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.
- B. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 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 until cast-in-place concrete has attained its design compressive strength.

3.03 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of base plate.
 - 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 base or bearing plate before packing with grout.
 - 4. Promptly pack grout solidly between bearing surfaces and base or bearing 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 and architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Surveys: Establish permanent benchmarks necessary for accurate erection of structural steel. Check elevations of concrete surfaces, and locations of anchor bolts and similar items, before erection proceeds.
- E. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- F. Splice members only where indicated, unless, with the Engineer's approval, splices not indicated would result in lower costs due to reduced shipping or other expenses. For splices not indicated, submit structural calculations prepared and signed by a Civil engineer licensed to practice where the project is located.

- G. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- H. Do not use thermal cutting during erection, unless approved specifically by the Engineer. When gas cutting is permitted, finish the gas cut section to a sheared appearance.
- I. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.04 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 - 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
 - 4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

3.05 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

3.06 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000.
- B. Bolted Connections: Bolted connections will be tested and inspected according to CBC, AISC 360, and RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - 1. Bolt tightness shall be checked at the following rates:
 - a. A minimum of 10 percent of all bolted joints, selected at random.
 - b. A minimum of two bolts per joint.
 - c. All high-strength bolts.

- C. Welded Connections: Field welds will be visually inspected according to CBC and AWS D1.1/D1.1M.
 - 1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. Complete Penetration Groove Welds: Complete penetration groove welds contained in the beam to column joints of the moment frames shall be tested 100 percent either by ultrasonic testing or by radiography.
 - 1. At other than moment frame beam to column connections, base metal thicker than 1-1/2-inches, when subjected to through-thickness weld shrinkage strains, shall be ultrasonically inspected for discontinuities directly behind such welds. Test shall be performed
 - 2. Backing Strips: Backing bar of the bottom flange of moment frame beam shall be removed. Back-gouge weld root to sound material. Provide magnetic particle test for defects. Reweld root area with 5/16-inch fillet weld.
- E. Shear Connectors: 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. Revise subparagraph below if an actual amount or percentage of shear connectors requires testing.
 - 3. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.
- F. Deficiencies: Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.
 - 1. Reinspection: After correction of deficiencies, additional inspections and tests will be performed to verify that structural steel Work complies with the requirements.
 - 2. Reinspection Costs: Cost of reinspections shall be the responsibility of the Contractor.

3.07 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780 and the repair paint manufacturer's written instructions..
- B. Touch-up 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.
 - 2. Primed structural steel members showing evidence of rusting over 25 percent or more of any surface after erection shall be rejected.
- C. Painting: see additional requirements in Division 9.

END OF SECTION

- SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Custom fabricated items from steel, aluminum, and plates, bars, strips, tubes, and pipes that are not a part of structural steel or other metal framing systems, including, but not necessarily limited to, the following:
1. [Handrails, guardrails, and railings related to concrete stairs and ramps.](#)
 2. Other miscellaneous fabrications detailed, specified, or required, including:
 - a. Inserts and anchoring devices built into framing for installation of miscellaneous metal and other required work.
 - b. Lintels, clip angles, and continuous angles.
 - c. Sheet metal thicker than No. 10 U.S. Standard gage (approximately 0.14-inch thick), unless otherwise specified.
 - d. Sleeves that are not provided under other Divisions.
- B. Referenced Sections:
1. Section 012500 - Substitution Procedures.
 2. Section 013300 - Submittal Procedures.
 3. Section 017419 - Construction Waste Management and Disposal.
 4. Section 099600 - High Performance Coatings.

1.02 REFERENCES

- A. ASTM International (ASTM):
1. A 27-10 - Specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for.
 2. A 36-05 - Specification for Structural Steel.
 3. A 47-13 - Specification for Ferritic Malleable Iron Castings.
 4. A 53-12 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 5. A 123-12 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 6. A 153-05 - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 7. A 307-04e01 - Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
 8. A 325-06 - Specification for High-Strength Bolts for Structural Joints.
 9. A 500-10a - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

10. A 653-07 - Specification for Steel Sheets, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 11. A 1008 12a - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 12. A 1011-12a - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 13. B 209-06 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 14. B 210-12 - Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.
 15. B 221-12a - Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
 16. B 429-10 - Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 17. F 844-07a - Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
- B. California Building Standards Code (CBSC):
1. California Building Code [CCR Title 24, Part 2] (CBC), 2013 edition:
 - a. Chapter 10 - Means of Egress.
 - b. Chapter 11B - Accessibility to Public Buildings, Public Accommodations, Commercial Buildings, and Public Housing:
 - 1) Division 3 - Building Blocks.
 - a) Section 11B-309 - Operable Parts.
 - 2) Division 4 - Accessible Routes.
 - a) Section 11B-404 - Doors, Doorways, and Gates.
 - b) [Section 11B-405 - Ramps.](#)
 - (1) [11B-405.2 - Slope.](#)
 - (2) [11B-405.3 - Cross Slope.](#)
 - 3) [Division 5 - General Site and Building Elements.](#)
 - a) [Section 11B-505 - Handrails.](#)
 - (1) [11B-505.5 - Clearance.](#)
 - (2) [11B-505.6 - Gripping Surface.](#)
 - (3) [11B-505.10 - Handrail Extensions.](#)
 - c. Chapter 16A - Structural Design.
 - 1) [Section 1607A - General Design Requirements:](#)
 2. California Fire Code [CCR Title 24, Part 9] (CFC), 2013 edition.
 - a. Chapter 26 - Welding and Other Hot Work.
 - 1) Section 2604 - Fire Safety Requirements.
 - a) 2604.1 - Protection of Combustibles.
 - b) 2604.2 - Fire Watch.
 - c) 2604.3 - Area Reviews.
 3. California Green Building Standards Code (CALGreen Code) [CCR Title 24, Part 11] (CGC), 2013 edition.

C. American Institute of Steel Construction (AISC):

 1. *Code of Standard Practice* for Steel Buildings and Bridges.
 - a. Section 10 - Architectural Exposed Structural Steel (AESS).

- D. American Iron and Steel Institute (AISI):
 - 1. 9 002 - Welding of Stainless Steels and Other Joining Methods.
- E. American National Standards Institute (ANSI):
 - 1. A14.3 - Type I Industrial Ladders.
 - 2. B18-22.1 - Plain Washers.
- F. American Welding Society (AWS):
 - 1. D1.1 - Structural Welding Code - Steel.
 - 2. D1.3 - Structural Welding Code--Sheet Steel.
 - 3. D1.4 - Structural Welding Code--Reinforcing Steel.
 - 4. D1.8 - Structural Welding Code--Seismic Supplement.
- G. ICC Evaluation Service, Inc. (ICC ES), a subsidiary corporation of the International Code Council:
 - 1. ICC ES Evaluation Reports, Materials, Products, Methods and Types of Construction published after February 1, 2003 (ESR-).
- H. National Association of Architectural Metal Manufacturers (NAAMM):
 - 1. AMP 500-06 - *Metal Finishes Manual*.
- I. The Society for Protective Coatings (SSPC):
 - 1. *Steel Structures Painting Manual*.
 - a. Volume 1 - Good Painting Practice, 3rd edition.
 - b. Volume 2 - Systems and Specifications, 7th Edition, including Specifications, Guides, Procedures, and Supplements:
 - 1) SP-1 - Solvent Cleaning.
 - 2) SP-2 - Hand Tool Cleaning.
 - 3) SP-6 - Commercial Blast Cleaning (NACE 3).
- J. Military Specifications (MIL):
 - 1. MIL-P-21035 - Paint, High Zinc Dust Content Galvanizing Repair.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Refer to Section 017419 regarding procedures for implementing construction waste management requirements.

1.04 SUBMITTALS

- A. Product Data: In accordance with the provisions of Section 013300, submit complete manufacturer's descriptive literature and specifications.
- B. Shop Drawings: In accordance with the provisions of Section 013300, submit complete Shop Drawings comprehensively describing fabrication and installation of metal fabrications, including:
 - 1. Plans, elevations, and sections drawn to a scale of 1 inch equals 1 foot.
 - 2. Details drawn to a scale of 3 inches equals 1 foot.
 - 3. Setting drawings, templates, and instructions for installation of anchorage devices as required.
- C. Samples: In accordance with the provisions of Section 013300, submit samples as follows:
 - 1. Manufacturer's standard palettes for the selection of colors and finishes for proprietary items.

2. Custom coating colors stipulated by the Architect, for review and acceptance.
 3. Items noted in material articles in Part 2.
- D. Quality Control Submittals: In accordance with the provisions of Section 013300, submit the following:
1. Test Reports: Submit certified laboratory test reports confirming physical characteristics of materials used in the performance of the work of this Section.

1.05 QUALITY ASSURANCE

- A. Welder's Qualifications: Currently certified in accordance with AWS D1.1.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: When required for the protection of finish, deliver metal materials, components, and assemblies wrapped with identifying labels affixed and legible. The Architect reserves the right to observe deliveries, review bills of lading, and to reject the following:
1. In the case of items accepted under proprietary designation, items not identifiable as specified products of the accepted manufacturer.
 2. Items not properly shop primed as required.
 3. Factory prefinished items exhibiting damage to such finish not repairable by conventional and minor field touch-up procedures.

1.07 FIELD CONDITIONS

- A. Field Measurements: Prepare required Shop Drawings based on field measurements taken specifically for the work of this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Grouts:
1. Five Star Products Inc., Fairfield, CT (800)243-2206.
 2. Master Builders, Los Angeles, CA (213)868-4726.
 3. L&M Construction Chemicals, Inc., Omaha, NE (402)453-6600, (800)362-3331.
- B. Fasteners:
1. ITW Ramset/Red Head, Wood Dale (800)354-7432.
- C. Primers:
1. Rust-Oleum Corporation, Vernon Hills, IL (312)367-7700, (800)323-0851, and represented by Vista Paint, Fullerton, CA (714)380-6800.
 2. Tnemec Company, Inc., Kansas City, MO (816)483-3400, represented by TPC Consultants, Inc., Compton, CA (310)637-2363.
- D. Like materials shall be the products of one manufacturer and shall be either the ones upon which the design is based or equal products of other manufacturers accepted in advance in accordance with Section 012500.

2.02 REGULATORY REQUIREMENTS

- A. Regulations: Use materials conforming to the regulations of the local air quality management district in force at the time of application.
 - 1. Comply with welding and other hot work preparation in accordance with provisions of CFC 2604.1 to 2604.3.1.
- B. Waste Management: Comply with CALGreen Section 5.408 Construction Waste Reduction, Disposal and Recycling. Establish a construction waste management plan for the diverted material.
 - 1. Recycle or salvage for reuse a minimum of 50 percent of the non-hazardous construction and demolition waste in accordance with CALGreen 5.408.1.3.
- C. Comply with CALGreen 5.504.4.3 Paints and Coatings:
 - 1. Architectural paints and coatings shall comply with VOC limits in Table 5.504.4.3.
 - 2. Aerosol paints and coatings shall comply with CALGreen 5.504.3.1

2.03 PERFORMANCE/DESIGN CRITERIA

- A. Design Requirements: Where designated as AESS on Contract Drawings, comply with requirements of Section 10 of AISC *Code of Standard Practice* for Architecturally Exposed Structural Steel (AESS) regarding:
 - 1. Material and erection tolerances.
 - 2. Surface appearance and weld show-through.
 - 3. Welding and joint uniformity.
 - 4. Delivery of material.
 - 5. Deflection limitations.

2.04 MATERIALS

- A. General: Miscellaneous metal work that will be exposed to view shall be fabricated of materials that are smooth and free of pitting, seam marks, roller marks, rolled trade names, roughness, and other surface blemishes.
 - 1. Provide miscellaneous steel, framing, supports, and other items required to complete work, whether or not indicated on Contract Drawings.
 - 2. Provide, as part of this Section, miscellaneous small parts of material No. 10 gage and thinner than No. 10 gage, or items specifically called out in this Section, when those items are incorporated into the assembly or its installation, and is a normal and accepted part of the work.
- B. Steel:
 - 1. Components of exterior steel fabrications shall be hot dipped galvanized in accordance with ASTM A 53, ASTM A 123, ASTM A 153, or ASTM A 653, as applicable.
 - a. Galvanizing shall be Class G60 unless specified otherwise.
 - 1) Exterior metal fabrications within 5 miles of ocean shores or salt water bodies shall be Class G90.

- b. Refer to Article 2.07-H for galvanizing of metal fabrications after fabrication.
 2. Plates, Shapes, and Bars: ASTM A 36, except as otherwise indicated on Contract Drawings.
 3. Structural Sheet: ASTM A 1011 hot-rolled, or ASTM A 1008 cold-rolled, Class 1, grades as required for design loading.
 4. Pipe: Provide standard weight (Schedule 40), unless otherwise indicated or specified.
 - a. Columns: ASTM A 53, Type S, Grade B structural, black finish, unless galvanizing is required.
 5. Tubing: ASTM A 500, Grade B, cold-formed.
 6. Brackets, Flanges, and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.
- C. Aluminum:
1. Provide extruded aluminum shapes in accordance with ASTM B 221 and ASTM B 429 for Alloy 6063, temper as required.
 2. Provide aluminum sheet and plate in accordance with ASTM B 209 for 5052 Temper H32.
 3. Bolts, Nuts, and Washers: Stainless steel.

2.05 HANDRAILS, GUARDRAILS, AND RAILINGS - STEEL

- A. General: Comply with uniform and concentrated load requirements of CBC 1607A.7.1.
- B. Materials:
 1. Steel Shapes: As indicated in Contract Documents.
- C. Handrail Brackets: Custom fabricated with steel bar stock as indicated in Contract Documents. Locate 6 feet on centers maximum. Provide backing plate spacer appropriate to substrate and secure to structural substrate with 3/8-inch diameter concealed bolt as recommended by manufacturer.
 1. Mount handrails 1-1/2 inches clear from side walls in accordance with 11B-505.5.
 2. Refer to Paragraph 3.01-A for examination of wall surface.
 3. The maximum projection of handrails into the clear width of ramps at handrail height shall be 3-1/2-inches on each side, in accordance with CBC 11B-405 Ramps.
- D. Fabrication: Fabricate of steel pipe, tubing, bars, or solid stock in accordance with dimensions and details shown on the Contract Drawings. Handrails for stairs and ramps shall be 1-1/4-inches to 1-1/2 inches in outer diameter.
 1. Refer to Contract Drawings for height of handrails.
 2. Railings shall be mitered and welded. Fabricate bends in suitable jigs without crushing pipe.
 - a. Connections shall be bolted, brazed, or welded, as indicated on the Contract Drawings.
 3. Join posts, rails, and corners by fitting posts to top rails, fitting intermediate rails to posts, mitering corners, grooving welding joints.

and grinding smooth without sharp or abrasive corners, edges, or surfaces.

- a. Welding shall conform to the AESS requirements of Section 051213.
 - b. Tops and sides of gripping surfaces shall not be uninterrupted by newel posts, construction elements, or other obstructions.
4. Butt railing splices and reinforce with tight-fitting interior sleeves 6 inches long. Adjust railings prior to anchoring to ensure matching alignment at butting joints. Plumb posts in each direction. Secure posts and rail ends to building construction as required.
- a. Provide end caps at all rail terminations and grind smooth.
 - b. Provide elbow returns equal to Julius Blum No. 926.

E. Finish:

1. Shop prime exposed steel surfaces.
2. Exterior: Prime and finish as specified in Section 099600.

F. Installation: Set posts in core drilled holes with quickset grout in color to match adjacent paving.

1. Wheel guide rails or guide curbs shall provide a continuous and uninterrupted barrier along the length of a ramp, in accordance with CBC 11B-505.10.

2.06 COMPONENTS

- A. Concrete Inserts: Threaded or wedge type, galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims manufactured from ASTM A 153 hot-dipped galvanized steel.
 1. Pipe Sleeves: Standard weight wrought iron, with an inside diameter 1/2-inch greater than outside diameter of penetrating pipe.
- B. Concrete Fill: In accordance with Section 033000.
- C. Non-Shrink Grouts: In accordance with Section 033000.
- D. Filler Metals for Shielded Metal Arc Welding: E70XX low hydrogen electrodes complying with AWS D1.1.
- E. Fasteners: Provide zinc-coated fasteners where used in exterior or other wet areas, or where built into exterior walls. Select fasteners for the type, grade, and class required.
 1. Bolts and Nuts: Regular hexagon head type, ASTM A 307 and ASTM A 325, as required by Contract Structural Drawings.
 - a. Nuts of the self-locking type may be used instead of upsetting the bolt threads where specified.
 - b. Lag Bolts: Square head type.
 - c. Bolts used in conjunction with stainless steel fabrications shall be manufactured of stainless steel.
 2. Screws:
 - a. Machine Screws: Cadmium plated steel.
 - b. Wood Screws: Flat head carbon steel.
 3. Washers:
 - a. Plain Washers: Round, carbon steel, plain (flat) unhardened steel, conforming to ASTM F 844.

- b. Lock Washers: Helical spring type carbon steel.
 - c. Bevel Washers: Square shape with hole 1/16-inch greater than bolt size up to 1-inch bolts, and 1/8-inch greater than bolt size where bolt is larger than 1 inch diameter.
 - d. Power-Driven Fasteners: Low velocity powder-activated fasteners, as manufactured by Hilti (ICC ES ESR-2184 or ER-1663), ITW Ramset (ICC ES ESR-1955), or equivalent, and provided with steel washers.
4. Concrete Anchorage Devices: Expansion shields, FS FF-S-325.
 5. Toggle Bolts: Tumble-wing type, FS FF-B-588, type and style as required.
- F. Shop Primer:
1. Weather-Protected Steel: Conform to the regulations of the air quality management district in force at the time of application. Select primer that is compatible with finish coats of paint. Coordinate selection of metal primer with finish paint requirements specified in Section 099100.
 - a. Tnemec Series 10-99 Modified Alkyd Rust-Inhibitive Primer, red, green, or gray color, manufactured by Tnemec Company, Inc.
 - b. Rust-Oleum 6100 System low VOC modified alkyd Shop Coat Primer, manufactured by Rust-Oleum Corporation.
 - c. Where a high performance finish coating will be required on interior surfaces, provide primer as specified for weather-exposed steel.
 2. Weather-Exposed Steel: Conform to the regulations of the air quality management district in force at the time of application. Select primer that is compatible with finish coats of paint. Coordinate selection of metal primer with coating system requirements specified in Section 099100 and Section 099600, as applicable.
 - a. Tnemec Series 90-97 Tneme-Zinc, manufactured by Tnemec Company, Inc.
 - b. Zinc Clad II HS Inorganic low-VOC zinc-rich primer, manufactured by Sherwin Williams.
- G. Field Repair Galvanize Coating: Galvax Cold Galvanizing Paint 95% Zinc, manufactured by Fastenal Company, or ZRC Galvilite Galvanizing Repair Compound, manufactured by ZRC Worldwide, or equal.

2.07 FABRICATION, GENERAL

- A. Specified Items: Refer to Articles in Part 2 for fabrication of specific items.
- B. General: Use materials of size and thickness shown or, if not shown, of size and thickness required to produce strength and durability in finished product. Fabricate to field dimensions using proven details of fabrication and support. Use type of materials shown or specified for various components of work.
1. Use hot-rolled bars for work fabricated from bar stock, unless shown or specified to be fabricated from cold-finished or cold-rolled stock.
 2. Fabricate units with continuously welded joints and smooth exposed edges.
- C. Miscellaneous Steel Trim: Provide shapes and sizes as required for profiles shown. Except as otherwise noted, fabricate units from structural

steel shapes, plates, and bars with continuously welded joints and smooth exposed edges. Provide cutouts, fittings, and anchorages as required for coordination of assembly and installation of other work.

- D. Welding: Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32-inch unless otherwise indicated on Contract Drawings. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
 - 1. Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush, to match and blend with adjoining surfaces.
 - 2. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type shown or, if not shown, Phillips flat-head countersunk screws or bolts.
- E. Provide type of anchorage compatible with supporting structure. Fabricate and space anchoring devices as indicated on the Contract Drawings, in accordance with applicable codes, and as required by accepted engineering practice to provide support for intended use.
- F. Cut, reinforce, drill, punch, and tap metal work as required to receive finish hardware and similar items. Remove burrs and ease edges to a radius of approximately 1/32-inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- G. Shop Assembly: Preassemble items in shop to greatest extent 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.
- H. Hot-Dip Galvanizing: Provide materials with a zinc coating for those items indicated or specified to be galvanized, as follows:
 - 1. Comply with ASTM A 123 for galvanizing rolled, pressed and forged steel shapes, plates, bars and strip 1/8-inch thick and heavier, and assembled steel products.
 - a. Coating shall be continuous, and as reasonably smooth and uniform in thickness as the weight, size, shape of the item, and necessary handling of the item during the dipping and draining operations at the galvanizing kettle will permit.
 - 1) Galvanized finish shall comply with AESS requirements of Paragraph 2.03-A.
 - b. Galvanized Finish: Provide galvanized finish within the range of color and surface textures presented in the mockups.
 - 2. Comply with ASTM A 123 for galvanizing rolled, pressed and forged steel shapes, plates, bars and strip 1/8-inch thick and heavier, and assembled steel products.
 - 3. Comply with ASTM A 153 for galvanizing iron and steel hardware to be centrifuged or otherwise handled to remove excess zinc.
 - 4. Hot dip galvanize exterior ferrous metal work after fabrication.

5. Assemble work in sections as large as can be handled by galvanizing equipment.
 6. Remove projections, barbs, and icicles after galvanizing.
 7. Provide galvanizing at items permanently exposed to the exterior and other interior wet areas, or where built into exterior walls. Items located at other areas shall be shop primed and field finished in accordance with Section 099100, except where finish is omitted due to sprayed fireproofing.
 - a. Exterior members specified to be galvanized shall receive urethane coating system specified in Section 099600.
- I. Shop Priming:
1. Weather-Protected Steel: Shop prime miscellaneous metal work, except members or portions of members to be embedded in concrete or masonry, surfaces and edges to be field welded, and galvanized surfaces, unless otherwise specified.
 - a. Remove scale, rust, and other deleterious materials before applying shop coat.
 - 1) Clean oil, grease, and similar contaminants in accordance with SSPC SP-1.
 - 2) Clean off heavy rust and loose mill scale in accordance with SSPC SP-2.
 - b. Immediately after surface preparation, brush or spray-on primer in accordance with manufacturer's instructions, and at a rate providing a minimum dry film thickness of 2 mils for each coat. Use painting methods which will result in full coverage of joints, corners, edges, and exposed surfaces.
 - c. Apply one shop coat to fabricated metal items, except apply two coats of paint to surfaces inaccessible after assembly or erection. Tint color of second coat to distinguish it from first.
 2. Weather-Exposed Steel: Shop prime miscellaneous metal work exposed to the weather or as part of an assembly exposed to the weather in accordance with manufacturer's instructions, and at a rate providing a minimum dry film thickness of 2.5 to 3.5 mils for each coat. Use painting methods which will result in full coverage of joints, corners, edges, and exposed surfaces.
 - a. Remove scale, rust, and other deleterious materials before applying shop coat in accordance with requirements for weather-protected steel.
 - 1) Additionally, clean surfaces to bare metal in accordance with SSPC SP-6.
 - b. Immediately after surface preparation, prime in accordance with the requirements of Section 099600 as appropriate for type of substrate.
 - 1) Primer shall be coordinated with coating systems proposed for use in Section 099600.
 3. Weather-Exposed Steel: Omit shop primer for galvanized members exposed to the weather. Refer to Section 099100 for field priming and finishing of galvanized steel surfaces.

- J. Finish:
 - 1. Interior: Items not otherwise coated but exposed to view shall be prepared and painted in accordance with Section 099100.
 - 2. Exterior: Paint in accordance with Section 099100. Apply urethane coating in accordance with Section 099600. Provide color selected by Architect from manufacturer's standard color palette.

2.08 FABRICATION, SPECIFIED ITEMS

- A. Refer to Articles in Part 2 for fabrication of specific items.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Handrails: Verify that surfaces adjacent to wall mounted handrails are smooth with rounded edges, and free of sharp or abrasive elements.

3.02 INSTALLATION, GENERAL

- A. General: Provide anchoring devices and fasteners to secure miscellaneous metal items to in-place construction, including threaded fasteners for concrete and masonry inserts, toggle bolts, and other connectors as required.
 - 1. Provide galvanized or stainless steel fasteners at exterior locations.
- B. Cutting and Fitting: Perform cutting, drilling, and fitting required for installation of miscellaneous metal items. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch-up with shop paint coat. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- C. Placement: Set work accurately in location, alignment, and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.
 - 1. Where free standing, set posts in core drilled holes with quickset grout in color to match adjacent paving.
- D. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.
- E. Dissimilar Metals: Provide a separator at contact surfaces of dissimilar materials wherever there is a possibility of corrosive or electrolytic action.
 - 1. Use polystyrene to separate aluminum from relatively small areas of stainless steel, galvanized steel, and zinc.
 - 2. Use zinc chromate primer or bituminous paint to separate aluminum from cured concrete, mortar, or plaster.

3.03 INSTALLATION, SPECIFIED ITEMS

- A. Refer to Articles in Part 2 for installation of specific items.

3.04 ADJUSTING

- A. Touch-up 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. Apply by brush or spray to provide a minimum dry film thickness of 2 mils.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and apply two coats of field repair galvanize coating.
- C. Items not requiring refinishing shall be cleaned free of foreign matter.
- D. Lubricate and adjust swinging gates for smooth operation.

3.05 CLEANING

- A. Waste Management: Recycle or salvage waste steel materials in accordance with Section 017419.

END OF SECTION

- SECTION 060573 - WOOD TREATMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Wood construction required for moisture-sensitive locations, including the following:
 - 1. Wood preservative treatment.
 - 2. Roof-related rough carpentry, including plywood canopy decks required for roofing work.
 - 3. Wood blocking on roof for pipe support.
 - 4. Telephone backboards and miscellaneous plywood backing.
 - 5. Wood substrate for countertops and supports.
 - 6. Miscellaneous blocking, draft stops, nailers, and grounds.
- B. Referenced Sections:
 - 1. Section 012500 - Substitution Procedures.
 - 2. Section 013300 - Submittal Procedures.
 - 3. Section 017419 - Construction Waste Management and Disposal.
 - 4. Section 076200 - Sheet Metal Flashing and Trim.
- C. Coordinate with construction waste management requirements specified in Section 017419.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. A 153-09 - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 2. A 653-15 - Specification for Steel Sheets, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. California Code of Regulations (CCR):
 - 1. Title 24, Part 2- California Building Code (CBC), 2013 edition:
 - a. Chapter 23 - Wood:
 - 2. Title 24, Part 11 - California Green Building Standards Code (CALGreen Code) (CGC), 2013 edition.
- C. American Wood-Preservers Association (AWPA):
 - 1. U1 - Use Category System (UCS).
 - 2. Appendix H - Evaluating Preservatives for Remedial Treatment.
- D. APA-The Engineered Wood Association (APA):
 - 1. Design/Construction *Guide*, Residential & Commercial.

- E. ICC Evaluation Service, Inc. (ICC ES), a subsidiary corporation of the International Code Council:
 - 1. ICC ES Evaluation Reports, Materials, Products, Methods and Types of Construction published after February 1, 2003 (ER-).
- F. U.S. Department of Commerce Product Standards (PS):
 - 1. 1-83 - Softwood Plywood/Construction and Industrial.
 - 2. 20-70 - American Softwood Lumber Standard.
- G. West Coast Lumber Inspection Bureau (WCLIB):
 - 1. Grading and Dressing Rules *No. 17*.
- H. Western Wood Products Association (WWPA):
 - 1. Western Lumber *Grading Rules*, 2005 edition.

1.03 SUBMITTALS

- A. Product Data: In accordance with the provisions of Section 013300, submit complete manufacturer's descriptive literature and specifications for pressure treatment products, fasteners, and accessories.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials rigged for lifting. The Architect reserves the right to observe delivered materials, to review the accompanying bills of lading, and to reject lumber products not exhibiting appropriate grade and quality marks.
 - 1. Protect sheet materials from breaking corners and damaging surfaces while unloading.
- B. Storage: Store materials a minimum of 6 inches above ground on framework or blocking and cover with protective waterproof covering providing for adequate air circulation or ventilation.
 - 1. Do not store seasoned materials in wet or damp portions of the site or building.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Pressure Treatment Product Manufacturers:
 - 1. J.H. Baxter & Company, San Matteo, CA (650)349-0201, www.jhbaxter.com.
 - 2. Osmose, Inc., Buffalo, NY (716)882-5905, www.osmosewood.com.
 - 3. Western Wood Preserving Company, Sumner, WA (253)863-8191, www.westernwoodpreserving.com.
- B. Acceptable Pressure Treatment Facilities:
 - 1. California Cascade Industries, Fontana, CA (909)357-2136, Sacramento, CA (916)736-3353, (800)339-6480, www.californiacascade.com.
 - 2. Other treatment facilities acceptable to Architect.
- C. Acceptable Fastener Manufacturers:
 - 1. Simpson Strong-Tie Company, Inc., Brea, CA (714)871-8373.
 - 2. Hilti Corporation, Tulsa, OK (918)627-9711, (800)979-8000.

- D. Like materials shall be the products of one manufacturer and shall be either the ones upon which the design is based or equal products of another manufacturer accepted in advance in accordance with Section 012500.

2.02 REGULATORY REQUIREMENTS

- A. Regulations:
1. Grading: Provide products graded in accordance with the following:
 - a. Lumber: Grading rules of WCLIB *No. 17* and WWPA *Grading Rules*.
 - b. Softwood Plywood: PS *1*.
 2. Marking: Each piece of lumber shall be factory-marked with grade mark of inspection agency evidencing compliance with grading rule requirements.
 - a. Lumber: WCLIB *No. 17*.
 - 1) Grade stamp shall contain legible symbol of grading agency.
 - 2) Mill number or name.
 - 3) Grade of lumber.
 - 4) Designation of species or species grouping or combination.
 - 5) Condition of seasoning at time of manufacture.
 - a) S-GRN: Unseasoned.
 - b) S-DRY: Maximum moisture content 19%.
 - c) MC-15 or KD: Maximum moisture content 15%.
 - b. Softwood Plywood: APA trademark.
 - c. Preservative Treated Lumber and Plywood: AWPB Quality Mark.
- B. Waste Management: Comply with CALGreen Section 5.408.1 Construction Waste Diversion:
1. Recycle or salvage for reuse a minimum of 50 percent of the non-hazardous construction and demolition waste in accordance with CALGreen 5.408.3.

2.03 LUMBER MATERIALS

- A. Lumber: Conform to WWPA Grading Rules and WCLIB No. 17, and PS 20.
1. Species:
 - a. Non-Structural Roof-Related Lumber Nailers: Douglas fir or No. 2 western hemlock.
 2. Dimensions: Drawings indicate nominal sizes. Provide actual dimensions conforming to PS *20* for moisture content specified for each use.
 3. Surfacing: Surface four sides (S4S), unless specified otherwise.
 4. Seasoning: S-Dry with 19 percent maximum moisture content for sizes 2 inches or less in nominal width.
- B. Plywood: Conform to APA PRP-108 and PS *1*. Where grade is not otherwise shown on the Contract Structural Drawings, comply with the following:
1. Panels: APA Rated Structural I Plywood Sheathing, Exposure 1.
 - a. Seasoning: Moisture content at the time roofing is installed shall be less than 19 percent.
 - b. Provide Exterior Exposure type where any edge or surface is permanently exposed to the weather.
 2. Backboards for Telephone and Electrical Panels: Exterior Exposure Classification 3/4-inch thick APA C/C plugged.

3. Countertop Substrate: Exterior Exposure Classification APA C/C plugged.
- C. Fasteners: Fasteners and accessories shall be hot dip galvanized in accordance with ASTM A 153.
 1. Fastening Lumber to Lumber: Cement coated or annular threaded nails of sufficient length to penetrate 1-1/4 inches into adjoining members, except as otherwise indicated.
 - a. All fasteners used with lumber in exterior locations shall be corrosion resistant type.
 2. Fastening Lumber or Sheathing Panels to Steel: Minimum No. 8 sheet metal screws through 5/8-inch diameter steel washers.
 3. Fastening Lumber or Sheathing Panels to Concrete or Masonry:
 - a. Specially threaded anchors of sufficient length to penetrate concrete a minimum of 1-1/2 inches, equal to Tapcon Concrete Anchors, manufactured by Illinois Tool Works, Buildex Division.
 - b. Drilled type expansion anchors shall be equal to Molly Fasteners. Products manufactured by ITW Ramset/Red Head or Hilti may be used if equivalent in pull-out strength.
 - c. Shot pins shall be powder-driven steel studs equal to Hilti, or ITW Ramset/Red Head (ICC ES ER-1955).
- D. Rough Hardware:
 1. Materials: Where in contact with copper-bearing wood preservative (such as CBA, CA, and ACQ), provide G185 galvanizing in accordance with ASTM A 653 or ASTM A 153 galvanizing to avoid a corrosive reaction with zinc.

2.04 WOOD TREATMENT MATERIALS

- A. Preservative Treated Wood Products: Treat lumber using vacuum pressure process complying with CBC requirements.
 1. Lumber and plywood designated to be preservative treated shall be pressure treated in compliance with recommended practices of AWPA Use Category System (UCS):
 - a. Interior, Dry, Above Ground: AWPA Use Category UC1.
 - b. Interior, Damp, Above Ground: AWPA Use Category UC2.
 2. Lumber shall be kiln dried to maximum moisture content of 19 percent after treatment and plywood shall be re-dried to maximum moisture content of 15 percent after treatment.
 3. Lumber and plywood shall be treated with Type A copper boron azole (CBA-A), Type B copper azole (CA-B), or Type C ammoniacal copper quat (ACQ-C) to a net retention in pounds cubic foot as follows:
 - a. AWPA Use Category UC1: 0.25 ACQ-C /0.20 CBA-A /0.10 CA-B.
 - b. AWPA Use Category UC2: 0.25 ACQ-C /0.20 CBA-A /0.10 CA-B.
 4. Provide materials complying with requirements of AWPA Standards, and complying with requirements of CBC Chapter 23.
 - a. Acceptable products include ACQ Preserve, Nature Wood, Wolmanized Natural Select, or equal.
 - 1) Lumber treated with creosote, pentachlorophenol, copper naphthenate, or copper 8-quinolinolate, and chromated copper arsenate (CCA) are unacceptable.

- 2) Chromated copper arsenate (CCA) may be used for highway construction, utility poles and pilings, and other locations recommended by AWWA where no human contact.
5. Wood nailers for use with roofing work shall be classified as UC2.

PART 3 - EXECUTION

3.01 PRESSURE TREATMENT

- A. Pressure-Treated Wood Products:
 1. Provide pressure-treated wood used in following areas:
 - a. Framing, blocking, furring, and nailing strips built into exterior concrete or masonry construction.
 - b. Wood in contact with earth, concrete, plaster, masonry, or steel.
 - c. Wood used for sills, screeds, cant strips, plates, blocking, gravel stops, nailers, and bucks.
 - d. Rough carpentry work for roofing applications.
 2. Apply two brush coats of same preservative used in original treatment to sawed or cut surfaces of treated lumber.
 - a. Field apply preservative to cut faces.

3.02 ROOF BLOCKING

- A. Roof-Related Rough Carpentry:
 1. Weather Protection: Rough carpentry installed in conjunction with roofing work shall be protected from exposure to the weather by roofing or flashing materials specified under Section 076200 on same day work is installed.
 2. Fastening Lumber or Sheathing Panels to Lumber:
 - a. Nails shall be spaced 12 inches on centers maximum and staggered across face of wood member. Fasteners also shall be located within 3 inches of each end of wood member.
 - 1) Provide a maximum spacing of 6 inches on centers, 8 feet each way from outside corners for roof edge blocking.
 - b. Nail heads shall be flush with wood surface and nails shall penetrate adjoining piece 1-1/4-inches minimum.
 - c. Withdrawal resistance of nails shall be a minimum of 100 pounds per nail.
 - d. Bolt heads and nuts that bear against face of wood shall be provided with metal washers
 - e. All 5/8-inch diameter and larger anchor bolts shall have malleable iron washers.
 - f. Machine nailing is not acceptable on 5/16-inch sheathing panels if penetration of top surface is more than manual nailing, or if minimum edge distances are not maintained.
 3. Fastening Lumber or Sheathing Panels to Steel:
 - a. Anchors shall be spaced 2 feet on centers maximum and staggered if lumber is greater than 5 inches wide.
 - b. Head of anchor shall be flat or countersunk flush with surface.
 - c. Withdrawal resistance of anchors shall be a minimum of 400 pounds per anchor or numbers of fasteners increased

accordingly from that specified. Provide minimum penetration of 1/4-inch through steel.

4. Fastening Lumber or Sheathing Panels to Concrete or Masonry:
 - a. Anchors shall be spaced 3 feet on centers maximum and staggered if lumber is greater than 5 inches wide.
 - b. Head of anchor shall be flat or countersunk flush with surface.
 - c. Withdrawal resistance of anchors shall be a minimum of 400 pounds per anchor or number of fasteners increased accordingly from that specified. Provide minimum penetration of 1-1/2 inches into concrete.

3.03 TELEPHONE BACKBOARD

- A. Telephone Backboard:
 1. Attach with screws at 24 inches on centers at edges.
 2. Refer to Divisions 26, 27, and 28 for application of backboards in electrical and telecommunications work.

3.04 FIELD QUALITY CONTROL

- A. Inspection:
 1. Roofing system manufacturer's local authorized field representative or Owner's full time Inspector will perform moisture content testing of roof-related lumber materials.

3.05 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

3.06 CLEANING

- A. During execution of this portion of the work, keep the premises in a neat, safe, and orderly condition, free from accumulations of sawdust, cut pieces, and debris.
 1. At the end of each working day, thoroughly sweep surfaces where refuse from this portion of work has settled.
 2. Remove the refuse to the area on the jobsite designated for refuse storage and in a container provided under this Section.
 3. Upon completion of this portion of the work, thoroughly broom clean surfaces in area of construction activities.

END OF SECTION

- SECTION 061800 -

GLUED-LAMINATED CONSTRUCTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Glue laminated wood beams.
- B. Steel hardware and attachment brackets.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- ~~B. Section 09 9000 - Painting and Coating: Field Finishing.~~

1.03 REFERENCE STANDARDS

- A. AITC 117 - Standard Specifications for Structural Glued Laminated Timber of Softwood Species; American Institute of Timber Construction; 2010.
- B. AITC A190.1 - American National Standard for Wood Products - Structural Glued Laminated Timber; American Institute of Timber Construction; 2007.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2005.
- D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2013.
- E. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2005.
- F. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2010.
- G. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2013.
- H. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts; 2007a.
- I. ASTM A563M - Standard Specification for Carbon and Alloy Steel Nuts [Metric]; 2007.
- J. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.
- K. ASTM D2559 - Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions; 2012a.

- L. ASTM D2898 - Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 2007.
- M. AWPA U1 - Use Category System: User Specification for Treated Wood; American Wood-Preservers' Association; 2012.
- N. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2010.
- O. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.
- P. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- Q. RIS (GR) - Standard Specifications for Grades of California Redwood Lumber; Redwood Inspection Service; 2000.
- R. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.
- S. WCLIB (GR) - Standard Grading Rules for West Coast Lumber No. 17; West Coast Lumber Inspection Bureau; 2004, and supplements.
- T. WWPA G-5 - Western Lumber Grading Rules; Western Wood Products Association; 2011.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials, application technique and resultant performance information.
- C. Shop Drawings: Indicate framing system, sizes and spacing of members, loads and cambers, bearing and anchor details, bridging and bracing, framed openings.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect members to AITC requirements for not wrapped.
- B. Leave individual wrapping in place until finishing occurs.
- C. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Glued-Laminated Structural Units:
 - 1. Sentinel Structures, Inc: www.sentinelstructures.com.
 - 2. Unit Structures: www.unitstructures.com.
 - 3. Western Wood Structures, Inc: www.westernwoodstructures.com.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.

2.02 GLUED-LAMINATED UNITS

- A. Glued-Laminated Units: Fabricate in accordance with AITC 117 Industrial grade.
 - 1. Verify dimensions and site conditions prior to fabrication.
 - 2. Cut and fit members accurately to length to achieve tight joint fit.
 - 3. Fabricate member with camber built in.
 - 4. Do not splice or join members in locations other than those indicated without permission.
 - 5. Fabricate steel hardware and connections with joints neatly fitted, welded, and ground smooth.
 - 6. Welding: Perform welding in accordance with AWS D1.1.
 - 7. After end trimming, seal with penetrating sealer in accordance with AITC requirements.

2.03 MATERIALS

- A. Lumber: DF-L 24F-V4 or 24FV-8 as noted on drawings lumber conforming to WCLB grading rules with 16 percent maximum moisture content before fabrication.
- B. Steel Connections and Brackets: ASTM A36/A36M weldable quality, galvanize per ASTM A123/A123M.
- C. Anchor Bolts: ASTM A325 (ASTM A325M) Type 1 heavy hex high strength bolts and ASTM A563 (A 563M) nuts; hot-dip galvanized to meet requirements of ASTM A153/A153M, matching washers.

2.04 WOOD TREATMENT

- A. Factory-Treated Lumber: Comply with requirements of AWPA U1 - Use Category System for pressure impregnated wood treatments determined by use categories, expected service conditions, and specific applications.
- B. Shop treat wood materials in accordance with manufacturer's instructions.

2.05 FABRICATION

- A. Fabricate glue laminated structural members in accordance with AITC Industrial grade.
- B. Welding: Perform welding in accordance with AWS D1.1.
- C. Verify dimensions and site conditions prior to fabrication.
- D. Cut and fit members accurately to length to achieve tight joint fit.
- E. Fabricate member with camber built in.
- F. Do not splice or join members in locations other than those indicated without permission.
- G. Fabricate steel hardware and connections with joints neatly fitted, welded, and ground smooth.
- H. After end trimming, seal with penetrating sealer in accordance with AITC requirements.
- I. Field Finishing of Members: Specified in Section 09 9000.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that supports are ready to receive units.
- B. Verify sufficient end bearing area.

3.02 PREPARATION

- A. Coordinate placement of bearing items.

3.03 ERECTION

- A. Lift members using protective straps to prevent visible damage.
- B. Set structural members level and plumb, in correct positions or sloped where indicated.
- C. Provide temporary bracing and anchorage to hold members in place until permanently secured.
- D. Fit members together accurately without trimming, cutting, splicing, or other unauthorized modification.
- E. Swab and seal the interior wood surfaces of field drilled holes in members with primer.
- F. Field Finishing: Specified in Section 09 9000.

3.04 TOLERANCES

- A. Framing Members: 1/2 inch maximum from true position.

END OF SECTION

- SECTION 071353 -

ELASTOMERIC SHEET WATERPROOFING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Elastomeric sheet membrane waterproofing system for retaining walls used at landscaping work, as indicated on Landscaping Contract Drawings. below grade horizontal and vertical surfaces.
- B. Related Sections:
 - 1. Section 012500 - Substitution Procedures.
 - 2. Section 013300 - Submittal Procedures.
 - 3. Section 017419 - Construction Waste Management and Disposal.
 - 4. ~~Section 334613 - Foundation Drainage: Coordination with drainage composite and perforated drain piping at footings.~~
- C. Related Sections:
 - 1. Section 042200 - Concrete Unit Masonry: Coordination with requirements for surface condition and preparation.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. C 836-12 - Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
 - 2. D 412-06a(2013) - Test Method for Rubber Properties in Tension.
 - 3. D 570-98(2010) - Test Method for Water Absorption of Plastics.
 - 4. D 882-12 - Test Methods for Tensile Properties of Thin Plastic Sheeting.
 - 5. D 3767-03(2008) - Practice for Rubber Measurement of Dimensions.
 - 6. D 5385-93(2006) - Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes.
 - 7. E 96-12 - Test Methods for Water Vapor Transmission of Materials.
- B. California Building Standards Code (CBSC):
 - 1. California Green Building Standards Code (CALGreen Code) [CCR Title 24, Part 11] (CGC), 2013 edition.

1.03 DEFINITIONS

- A. *Structural waterproofing* refers to waterproofing applied directly to surfaces being waterproofed.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Refer to Section 017419 regarding procedures for implementing construction waste management requirements.

- B. Preinstallation Meetings: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include review of special details and flashing.

1.05 SUBMITTALS

- A. Product Data: In accordance with the provisions of Section 013300, submit complete manufacturer's technical product data and specifications
- B. Shop Drawings: In accordance with the provisions of Section 013300, submit Shop Drawings indicating relationship of all elements of waterproofing system.
- C. Quality Control Submittals:
 - 1. Test Reports: Submit certified laboratory test reports confirming physical characteristics of materials used in the performance of the work of this Section.
 - a. Submit product test reports from a qualified independent testing agency indicating and interpreting test results of waterproofing for compliance with requirements, based on comprehensive testing of current waterproofing formulations.
 - 2. Certificates: Submit certificate from manufacturer stating that product is suitable for the intended use.
 - a. Submit manufacturer's certification stating materials ordered and supplied are compatible with each other, suited for locale and purpose intended, and shipped in sufficient quantity to ensure proper, timely installation.

1.06 CLOSEOUT SUBMITTALS

- A. Warranty Documentation: Submit copies of written warranty, as supplied by the applicator, agreeing to repair or replace defective coating work during the warranty period.

1.07 QUALITY ASSURANCE

- A. Qualifications: Licensed, certified, or otherwise approved in writing by the membrane manufacturer.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by waterproofing manufacturer based on testing and field experience.

1.08 FIELD CONDITIONS

- A. Apply membrane waterproofing system only when existing and forecasted conditions are within the time limits established by the manufacturer of the materials and products used.

1.09 WARRANTY

- A. Sheet Membrane Waterproofing: Provide written 10-year material warranty issued by the membrane manufacturer upon completion of the work.

- B. Contractor's Bonded Warranty: Warranty the installation of the waterproofing system and flashing to be watertight for a period of 2 years from the date of Substantial Completion. Make repairs during this warranty period to maintain the waterproofing watertight. Owner has the right, in the case of emergency, at any time during the warranty period and without invalidating the warranty, to make temporary repairs required to protect the building and the contents of the building from damage due to leakage through the installed waterproofing system.
- C. Bonds required for this project shall be set forth in the General Conditions.
- D. Final Inspection be conducted by the Quality Control Observer and the membrane manufacturer's technical department representative. Deficiencies found shall be corrected by applicator prior to issuance of warranty. If corrections are required for reinspection by the Quality Control Observer, cost of the Quality Control Observer's services and expenses shall be paid by Contractor.
- E. Disclaimers and Limitations: Manufacturer disclaimers and limitations on product warranties do not relieve the Contractor from furnishing a warranty on work that incorporates the products. Manufacturer disclaimers and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers for Waterproofing Membrane Products:
 - 1. BASF Construction Chemicals - Building Systems, Shakopee, MN (800)243-6739 [Technical], (800)433-9517 [Customer Service], www.buildingsystems.basf.com.
 - 2. Carlisle Coatings and Waterproofing Inc. (CCW), a division of Carlisle Syntec, Wylie, TX (800)527-7092, www.carlisle-ccw.com.
 - 3. Colloid Environmental Technologies Company (CETCO), Arlington Heights, IL (847)392-5800, (800)527-9948, www.cetco.com.
 - 4. Grace Construction Products, division of W.R. Grace and Co.-Conn., Cambridge, MA (617)876-1400, (800)892-1165, with sales offices in Costa Mesa, CA (800)852-0568, www.graceconstruction.com.
 - 5. Henry Roofing Systems, Huntington Beach, CA (323)583-5000, www.henry.com.
 - 6. W.R. Meadows, Inc., Elgin, IL (312)683-4500, with representation in Pomona, CA (909)469-2606, (800)342-5916.
- B. Design is based on the use of accessory products manufactured by one of the following manufacturers:
 - 1. Carlisle Coatings and Waterproofing Inc. (CCW), a division of Carlisle Syntec, Wylie, TX (800)527-7092, www.carlisle-ccw.com.
 - 2. Dow Chemical Company, Midland, MI (866)583-2585, www.dowbuildingmaterials.com.
 - 3. Gardener, Tampa, FL (813)367-0282, www.apoc.com.

4. Henry Roofing Systems, Huntington Beach, CA (323583-5000, *www.henry.com*).
 5. W.R. Meadows, Inc., Elgin, IL (312)683-4500, with representation in Pomona, CA (909)469-2606, (800)342-5916.
- C. Like materials shall be the products of one manufacturer and shall be either the ones upon which the design is based or equal products of other manufacturers accepted in advance in accordance with Section 012500.

2.02 REGULATORY REQUIREMENTS

- A. Regulations: Components of the waterproofing system shall comply with air quality management district regulations in force at the time of application.
- B. Waste Management: Comply with CALGreen Section 5.408 Construction Waste Reduction, Disposal and Recycling. Establish a construction waste management plan for the diverted material.
 1. Recycle or salvage for reuse a minimum of 50 percent of the non-hazardous construction and demolition waste in accordance with CALGreen 5.408.1.3.

2.03 PERFORMANCE CRITERIA

- A. Performance Requirements for Structural Waterproofing: The membrane shall exhibit physical characteristics no less beneficial than the following:
 1. Thickness: When tested in accordance with ASTM D 3767 Method A, an effective total minimum thickness of 60 mils.
 2. Tensile Strength (Film): When tested in accordance with ASTM D 882 Modified, 5000 pounds per square inch, minimum.
 3. Tensile Strength (Membrane): When tested in accordance with ASTM D 412 Modified, 325 pounds per square inch minimum.
 4. Crack Cycling: When tested in accordance with ASTM C 836 Modified, over 1/4-inch crack at 100 cycles, no effect at a minimum temperature of minus 10° F.
 5. Hydrostatic Head Resistance: When tested in accordance with ASTM D 5385, capable of resisting a hydrostatic head of 231 feet minimum.
 6. Permeance: When tested in accordance with ASTM E 96 Method B, 0.05 Perms [grains per square foot per hour per inch mercury gage] maximum.
 7. Water Absorption: When tested in accordance with ASTM D 570 for a period of 72 hours, not more than 0.10 percent absorption, by weight.

2.04 MATERIALS

- A. Membrane for Structural Waterproofing:
 1. Provide a self-adhering elastomeric sheet membrane, in sheet form, consisting of a layer of rubberized asphalt furnished, on one face, with a cross-laminated polyethylene film and, on the second face, with a disposable release sheet. Provide one of the following, or equal:
 - a. CCW Miradri 860/861 Sheet Membrane Waterproofing, manufactured by Carlisle Coatings and Waterproofing.
 - b. Bituthene System 4000, manufactured by Grace Construction Products.
 - c. Blueskin WP200, manufactured by Henry Roofing Systems.

- d. Sealtight Mel-rol, manufactured by W.R. Meadows.
- B. Vertical Protection Board: Manufacturer's standard vertical protection board, equal to one of the following:
1. CCW Protection Board-V, manufactured by Carlisle Coatings and Waterproofing.
 2. Styrofoam Brand Protection Board, manufactured by Dow Chemical.
 3. APOC 5620 Protection Panel, manufactured by Gardener.
 4. W.R. Meadows Protection Board.
- C. Horizontal Protection Board: Manufacturer's recommended asphaltic core protection board, approximately 1/8-inch thick, sandwiched between two inert non-woven glass reinforcing mat cap sheets, equal to one of the following:
1. CCW Protection Board-H, manufactured by Carlisle Coatings and Waterproofing.
 2. 990-31 Protection Board, manufactured by Henry Roofing Systems.
 3. Sealtight Protection Course PC-2, manufactured by W.R. Meadows.
- D. Accessory Materials: Provide, primers, liquid membrane, elastomeric mastic, and adhesives specifically formulated by the manufacturer for use with the waterproofing membrane system proposed for use.
1. Surface Conditioner (as required): Grace Bituthene System 4000 Surface Conditioner, or equal.
 2. Primer: Carlisle CCW-714 or AWP Water Based Primer, Grace Bituthene Water-Based Primer, Henry Roofing Systems Acquaprime Emulsion Primer, or equal.
 3. Liquid Membrane: Grace Bituthene Liquid Membrane, Henry Roofing Systems Elasto-Seal LM, or equal.
 4. Sheet Strips: 12 inches wide self-adhering, rubberized asphalt composite sheet strips of same material and thickness as sheet waterproofing.
 5. Elastomeric Mastic: Carlisle CCW-704, Henry Roofing Systems Polybitume Polymer Modified Sealing Compound, or equal.
 6. Adhesive: Henry Roofing Systems 230-21 Rigid Insulation Adhesive, or equal.
 7. Sealant: CCW-703 Vertical Grade Liqueal Membrane or CCW-201 Polyurethane Sealant.
 8. Termination Bar: Type 304 stainless steel or prefinished aluminum, approximately 1/8-inch thick by 1 inch wide predrilled at 9 inches on centers.
- E.9 Drainage Composite (Porous Protection) Panels: ~~In accordance with Section 334613:~~ Acceptable products:
1. Hydroduct 220, manufactured by W.R. Grace Company.
 2. CCW Miradrain 6200, manufactured by Carlisle Coatings and Waterproofing, or equal.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Curing: Confirm that concrete and masonry have cured for a period of not less than 7 days for structural concrete.
 - a. Lightweight concrete shall be cured for not less than 14 days.
 - 2. Concrete: Verify that concrete has been repaired in the following manner:
 - a. Bugholes over 1/2-inch in length and 1/4-inch deep shall be plugged with concrete and finished flush with surrounding surfaces.
 - b. Form tie rod holes shall be filled flush with surrounding surfaces.
 - c. Fins shall be ground smooth. Outside corners shall be free of sharp edges.
 - d. Scaling shall be removed to sound, unaffected concrete and the exposed area repaired.
 - e. Materials and methods used for repair work shall be compatible with the membrane material.
 - 3. Masonry: Verify that mortar joints in smooth texture masonry surfaces have been flush cut, and rough texture masonry surfaces have been parged.
 - 4. Moisture: Using an electronic moisture meter of industry-recognized design, verify that the moisture content of substrata is within the range stipulated by the manufacturer for waterproofing.
- B. Verify that penetrations through the waterproofing are rigidly installed and ready to receive waterproofing installation.
- C. Acceptance of Conditions: By commencing operations, Contractor acknowledges existing surface conditions as satisfactory, and accepts full responsibility for performance of work installed under this Section.

3.02 PREPARATION

- A. Surface Preparation for Structural Waterproofing:
 - 1. Prior to application of the waterproofing system, repair concrete and masonry substrata as required to provide sound surfaces to receive waterproofing. Provide surfaces free of voids, spalled areas, loose aggregate, and sharp protrusions, with no coarse aggregate visible. Remove contaminants from the exposed concrete surface, including dust, dirt, loose stones, and debris.
 - 2. Apply a 12-inch wide strip of elastomeric membrane centered over crack exceeding 1/16-inch wide.
 - 3. Cracks in concrete 1/16-inch to 1/4-inch shall be pre-treated with a 60-mil coating of liquid membrane 2 inches wide centered on the crack. Alternately, apply a 6-inch wide strip of elastomeric membrane centered over crack. Provide 3-inch end laps.
 - 4. Pre-treat horizontal to vertical inside corners with a 3/4-inch fillet of liquid membrane and a 12-inch strip of waterproofing membrane centered in each direction from corner.

5. Pre-treat outside corners with a minimum 12-inch strip of waterproofing membrane centered in each direction from corner.
 6. At horizontal to vertical intersections, extend liquid membrane each direction from corner and then install 12-inch wide membrane strip centered over corner.
- B. Surface Conditioning: Spray diluted surface conditioner with fine mist nozzle at the rate recommended by the manufacturer. Allow surface conditioner to thoroughly dry before installing waterproofing membrane.
- C. Primer: Spray or roll on, as recommended by manufacturer, diluted primer at the rate recommended by the manufacturer. Allow surface conditioner to thoroughly dry before installing waterproofing membrane.

3.03 INSTALLATION

- A. Membrane for Structural Waterproofing: Apply waterproofing membrane vertically in sections of 8 feet in length, or less. Press membrane securely in place with heavy hand pressure and with manufacturer-approved rollers, during application. At vertical surfaces, apply waterproofing membrane beginning at the low point of the surface and working to the high point in shingle fashion.
1. Seams: Edges and end seams shall be overlapped at least 6 inches. Apply succeeding sheets with a 6-inch minimum overlap and stagger end laps. Roll the entire membrane firmly and completely as soon as possible. Patch misaligned or inadequately lapped seams with membrane material. Slit any fishmouths, overlap the flaps, and repair with a 6-inch patch of membrane and roll in place. The edges of the patch shall be sealed with a troweling of liquid membrane.
 2. Edges and T-Joints: Terminate the membrane directly on vertical surfaces by pressing firmly to the wall surface. Press edges with a metal or hardwood tool.
 - a. Apply a troweled bead of liquid membrane to edges of vertical and horizontal terminations.
 3. Corners: Install a 12-inch minimum flashing strip of membrane centered on outside and inside corners. The edges of laps within 12 inches of corners shall be sealed with a 1-inch wide x 1/4-inch thick troweling of liquid membrane.
 4. Projections: Apply a double layer of membrane around posts or projections extending at least 6 inches in all directions and seal terminations with elastomeric mastic.
 5. Treat membrane seams, laps, and edges with 1/4-inch thick x 1-inch wide troweling of liquid membrane.
 6. Drains: Apply waterproofing membrane collar centered on drain and extend 6 inches beyond flange onto deck. Apply field membrane in full width centered over drain. Apply clamping ring in a 60-mil bed of liquid membrane or elastomeric mastic.
- B. Protection Board: Protect vertical waterproofing membranes with protection board.
1. Attach with protection board adhesive or two-sided adhesive tape, as applicable.

2. Install protection system the same day the membrane is applied to minimize exposure of membrane to sunlight.
- C. Drainage Composite: Install as indicated in Section 334613.

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Representative: Make arrangements necessary to have a trained employee of the manufacturer on site periodically during membrane waterproofing work to review installation procedures.
- B. Independent Third Party Inspection: Provide minimum 48-hour notification to Owner's waterproofing inspection service prior to the start of work.
 1. Waterproofing inspection service shall provide periodic and final inspections prior to application of protection board. Protection board and backfill shall not be installed until required repairs are completed and work is accepted in writing.
 2. Submit summary of project site observations, instructions, and report of waterproofing installation sequence.

END OF SECTION

- SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Interior and exterior joint sealing and caulking.
 - 1. Include sealants between glazing frames and adjacent building materials.
 - 2. [Include sealing of plumbing fixtures to wall and floors.](#)
 - 3. Refer to Section 088100 for glazing compounds.
 - 4. Include acoustical gasketing.
- B. Referenced Sections:
 - 1. Section 012500 - Substitution Procedures.
 - 2. Section 013300 - Submittal Procedures.
- C. Related Sections:
 - 1. Section 072100 - Thermal Insulation.
 - 2. Section 076200 - Sheet Metal Flashing and Trim.
 - 3. Section 085113 - Aluminum Windows: Specific requirements for sealants, by proprietary designation.
 - 4. Section 087105 - Door and Hardware Installation.
 - 5. Section 088100 - Glass Glazing: Glazing compounds.
 - 6. Section 092216 - Non-Structural Metal Framing.
 - 7. Section 092900 - Gypsum Board.
 - 8. Section 099100 - Painting.
 - 9. Section 321313 - Concrete Paving.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. C 834-10 - Specification for Latex Sealants.
 - 2. C 920-11 - Specification for Elastomeric Joint Sealants.
 - 3. C 1193-12 - Guide for Use of Joint Sealants.
- B. California Building Standards Code (CBSC):
 - 1. California Building Code [CCR Title 24, Part 2] (CBC), 2013 edition:
 - a. Chapter 7 - Fire and Smoke Protection Features.
 - 1) 714 - Fire-Resistant Joint Systems.
 - 2. California Green Building Standards Code (Cal Green Code) [CCR Title 24, Part 11] (CGC), 2013 edition.

- C. American Architectural Manufacturers Association (AAMA):
 - 1. 800-92 - Voluntary Specifications and Test Methods for Sealants.
- D. Underwriters Laboratories, Inc. (UL):
 - 1. Building Materials *Directory*.
- E. Glass Association of North America [consisting of Flat Glass Marketing Association, Glass Tempering Association, and Laminators Safety Glass Association] (GANA), *www.glasswebsite.com*:
 - 1. *Glazing Manual*, 2004 edition.
 - 2. *GANA Sealant Manual*, 2008 edition.

1.03 DEFINITIONS

- A. The terms *sealant* and *caulking* shall be considered interchangeable.

1.04 SUBMITTALS

- A. Product Data: In accordance with the provisions of Section 013300, submit complete manufacturer's descriptive literature and specifications.
- B. Shop Drawings: In accordance with Section 013300, submit Shop Drawings locating all sealants by product name.
- C. Samples: In accordance with the provisions of Section 013300, submit the manufacturer's standard palette of colors for Architect's selection.
 - 1. When selections have been made, submit samples of cured sealants, in colors selected, approximately 4 inches in length.
 - 2. Submit samples of materials in contact with sealants for adhesion and compatibility testing by the sealant manufacturer. Provide results of testing along with manufacturer's acceptance and recommendations of their use.
 - 3. Coordinate with work of other Sections relating to testing for compatibility, or in preparing mockups and field samples in advance of actual construction.
- D. Quality Control Submittals:
 - 1. Test Reports: Submit manufacturer's certified laboratory test reports for adhesion to project substrates confirming physical characteristics of materials used in the performance of the work of this Section, and in the compatibility of the materials in contact with sealants used.

1.05 CLOSEOUT SUBMITTALS

- A. Warranty Documentation: Submit copies of written warranty, signed by the manufacturer and the applicator, agreeing to repair or replace defective products and work during the warranty period.

1.06 QUALITY ASSURANCE

- A. Qualifications: Installers/Applicators shall be qualified, thoroughly trained, experienced, possessing the necessary skills, and are completely familiar with the specific requirements and techniques needed to perform the work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements: Deliver materials in original unopened containers or bundles with labels showing manufacturer, product name of designation, color, shelf life and installation instructions.
- B. Storage and Handling Requirements: Store materials in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Environmental Requirements: Apply sealant materials under environmental conditions no less stringent than those stipulated by the manufacturer.

1.09 WARRANTY

- A. Warranty materials and workmanship against loss of adhesion or cohesion, discoloration, or other degradation for a period of not less than 2 years.

PART 2 - PRODUCTS

2.01 REFERENCED MANUFACTURERS

- A. Design of sealant systems is based on the use of products manufactured by the following:
 - 1. BASF Construction Building Systems, Shakopee, MN (800)243-6739 [Technical], (800)433-9517 [Customer Service], *www.buildingsystems.basf.com*.
 - 2. Dow Corning Corporation, Midland, MI (517)496-4586, (800)662-0661, with sales offices in Irvine, CA (949)757-5000.
 - 3. GE Silicones, General Electric Company, Waterford, NY (800)255-8886, distributed by Sunshine Supply, Anaheim, CA (714)634-2900.
 - 4. Momentive Performance Materials, Albany, NY (866)485-0683, (518)533-4600, *www.momentive.com*.
 - 5. Norton Performance Plastics Corporation, a St. Gobain Company, Granville, NY (800)724-0883, *www.nortonplastics.com*.
 - 6. Ohio Sealants, Mentor, OH (440)255-8900, (800)227-6095, *www.osisealants.com*.
 - 7. Pecora Corporation, Harleysville, PA (215)723-6051, (800)523-6688, with sales offices in Los Angeles, CA (218)826-9007.
 - 8. PRC (Product Research & Chemical Corporation), Commercial Products, Gloucester City, NJ (609)456-5700, (800)257-8454, with offices in Glendale, CA (213)666-7512.
 - 9. Rhône-Poulenc Inc. (Rhodorsil), Monmouth, NJ (201)297-0100.
 - 10. Tremco Commercial Sealants & Waterproofing, Beachwood, OH (216)292-5000, (800)3212-7906, with offices in Los Angeles, CA (213)587-3000, *www.tremcosealants.com*.
 - 11. Sika, Lyndhurst, NJ (201)933-8800, with offices in Santa Fe Springs, CA (562)941-02313.
 - 12. United States Gypsum Company (USG), Chicago, IL (800)874-4968, (877)874-6655 [Sales], with offices in Ontario, CA (800)964-4874, *www.usg.com*.

- B. Design of accessory items is based on the use of products manufactured by the following:
1. Balco/Mercedes International, Buford, GA (678)546-3550, with representation at Architectural Accent, Inc., Fullerton, CA (714)441-3418, www.mercedesintl.com.
 2. Emseal Corporation, Rexdale, Ontario CANADA, (416)740-2090, doing business in USA as Emseal Joint Systems Ltd., Westborough, MA (508)836-0280.
 3. Illbruk, (Will-Seal), Minneapolis, MI (612)521-3555.
 4. Michael Rizza Company Inc., Boring, OR (503)663-2418, www.michaelrizzacollc.com.
 5. Polytite Manufacturing Corporation, Cambridge, MA (617)864-0930, distributed by W.R. Grace & Co., Masonry Products Division, Milwaukee, WI (800)558-7066.
 6. National Guard Products, Memphis, TN, www.ngpinc.com.
 7. [Pabco Gypsum \(acoustical putty\), Newark, CA \(800\)-797-8159, www.quietrock.com/products/quietseam-rf.](http://www.quietrock.com/products/quietseam-rf)
 8. Reese Enterprises, Huntington Beach, CA, www.reeseusa.com.
 9. Saint-Gobain Performance Plastics, The Specialty Elastomers sector, Wayne, NJ (973)696-4700 [headquarters], Hoosick Falls, NY (518)686-7301 [manufacturing and sales], www.sgppl.com.
 10. Williams Products, Inc., Troy, MI (248)643-6400, (800)521-9594, www.williamsproducts.net.
- C. Acceptable Manufacturers of Foam Sealant Tapes:
1. Saint-Gobain Performance Plastics, Granville, NY (518)642-2200, (800)724-0883, www.norseal.com.
 2. D.S. Brown Company Company, North Baltimore, OH (419)257-3561, www.dsbrown.com.
- D. Like materials shall be the products of one manufacturer and shall be either the ones upon which the design is based or equal products of other manufacturers accepted in advance in accordance with Section 012500.

2.02 REGULATORY REQUIREMENTS

- A. Regulations: Comply with CALGreen 5.504.4.1 Adhesives, Sealants, and Caulks: Adhesives, sealants, primers, and caulks in amounts greater than 16 ounces shall comply with SCAQMD Rule 1168 VOC limits, as indicated in Tables 5.504.4.1 and 5.504.4.2.
1. Aerosol adhesives and smaller sizes of adhesives and sealant or caulking shall comply with CCR Title 17, commencing with Section 94507.
- B. VOC Content of Interior Sealants: Provide sealants and sealant primers that comply with the following limits for low VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
- | | |
|---|----------|
| 1. Architectural Sealants: | 250 g/L. |
| 2. Nonmembrane Roof Sealants: | 300 g/L. |
| 3. Single-Ply Roof Membrane Sealants: | 450 g/L. |
| 4. Sealant Primers for Architectural, Nonporous Substrates: | 250 g/L. |
| 5. Sealant Primers for Architectural, Porous Substrates: | 775 g/L. |
| 6. Modified Bituminous Sealant Primers: | 500 g/L. |
| 7. Other Sealant Primers: | 750 g/L. |

2.03 SYSTEM DESCRIPTION

- A. General: Provide joint sealants in not less than the following circumstances:
 - 1. Where expansion and contraction occurs.
 - 2. Between materials and products where infiltration of moisture, water, light, or air blown particles may occur.
 - 3. Between materials and products in, or penetrating, sound-insulated walls, partitions, and related construction.
 - 4. Between dissimilar materials where they join on a surface or corner.
 - 5. Between materials and products in, or penetrating, fire-resistive construction.

2.04 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, 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: Custom colors as selected by Architect from manufacturer's standard color palette.

2.05 GASKETING

- A. Partition Closure Gaskets at Abutting Interior Partitions:
 - 1. Filler Gasket (at Window Mullions): Closed cell expanded neoprene, black premolded joint filler, equal to Everlastic Type NN1, 1040 Series, manufactured by Williams Products.
- B. Acoustical Gaskets:
 - 1. Self-Adhesive Sponge Neoprene Pads: **Type K1**, for providing a compressible filler and acoustical seal in the gaps of slip joints. Set in place with 10 to 15% compression. Airtight splices work in length-wise direction.
 - 2. [Self Adhesive Bubble Gaskets **Type K2**: See Paragraph 2.09-A.14.](#)
 - 3. [Acoustical Putty **Type K3**: QuietSeam RF manufactured by Pabco Gypsum, or equal.](#)
 - a. [Density: Approximately 40pcf.](#)

2.06 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Backer Rod Material: Provide flexible and compressible closed cell non-gassing polyethylene foam, rounded at contact surfaces, compatible with sealant, and as recommended by sealant manufacturer.
 - 1. Backer rods shall be sized and shaped to control depth of sealant. Provide compression upon insertion of 25 percent to 33 percent for closed-cell rods and 40% to 50% for open-cell rods.
 - 2. Provide open cell type at interior perimeter weather seals adjacent to weather resistant barriers.

3. Provide closed cell type at exterior perimeter weather seals adjacent to exterior wall finish.
4. Provide closed cell type adjacent to construction materials at other sealant locations

2.07 OTHER MATERIALS

- A. Primer: Non-staining type recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated.
- B. Joint Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

2.08 PRODUCT USAGE

- A. Exterior: Provide joint sealants at the following exterior locations:
 1. Traffic Bearing Joints in Paved Areas:
 - a. Level Areas up to 1 Percent Slope: **Type A1** and **Type A2**.
 - b. Horizontal Joints Exceeding 1 Percent Slope, and on Vertical Risers: **Type A2**.
 2. Dynamic Joints with Movement up to 50 Percent of Joint Width: **Type B1a** or **Type C1** or **Type D1a**, as appropriate, or as indicated on Contract Drawings.
 3. Non-Dynamic Joints:
 - a. General Use: **Type B2** or **Type C1**.
 - b. Wall Penetrations: **Type E1** or **Type C1**.
- B. Interior: Provide joint sealants at the following interior locations:
 1. Non Fire-resistive Rated Construction, Paintable:
 - a. Interior Static Joints: **Type E1** or **Type E2** or **Type F1**.
 - b. Plumbing Fixture Conditions: **Type D2**.
 - c. Wall Penetrations: **Type E1**.
 - d. Interior Door and Window Perimeters: **Type E2** or **Type F1**.
 - e. General Purpose Acoustical Applications: **Type F2**.
- C. Acoustical Gaskets:
 1. Self-Adhesive Sponge Neoprene Pads: **Type K1**, for providing a compressible filler and acoustical seal in the gaps of slip joints. Set in place with 10 to 15% compression. Airtight splices work in lengthwise direction.
 2. Self Adhesive Bubble Gaskets: **Type K2**, for providing an acoustical seal around the edge of an operating access panels (typically set on jamb or head frame or stop to act as a compression seal).
- D. Glazing Systems: Provide types of sealants at the following locations:
 1. Aluminum Frames:
 - a. Exterior Perimeter Weather Seals (adjacent to exterior wall finish): **Type D1a** or **D1e**.

- b. Interior Perimeter Weather Seals (adjacent to weather resistant barrier): **Type D1d**.
 - c. Interior Construction Sealants (adjacent to interior wall finish): **Type D1a**.
 - d. Glazing Sealants: **Type D1b**.
- E. Use only materials recommended by manufacturer for each specific application.

2.09 MATERIAL TYPES

- A. Sealants: Provide the following types in colors to match adjacent materials.
1. **Type A1** - Polyurethane Traffic Grade Sealant: Two-part, self-leveling; ASTM C 920, Type M, Grade P, Class 25, Use T; Shore hardness 30-40. Acceptable products:
 - a. Pecora NR-200 Urexpan.
 - b. PRC Permapol RC-2SL.
 - c. Sikaflex 2c SL.
 - d. BASF Sonolastic SL 2
 - e. Tremco Vulkem 245 SL (255 at wide joints).
 2. **Type A2** - Polyurethane Traffic Grade Sealant: Two-part, non-sag, cold-applied, chemically cured, traffic grade, Shore A of 40+; ASTM C 920, Type M, Grade NS, Class 25, Use T, M, A, and O. Acceptable products:
 - a. Pecora Dynatred.
 - b. Sikaflex 2c NS.
 - c. Tremco Vulkem 227.
 3. **Type B1a** - Polyurethane High Performance Sealant: Two-part, non-sag, highly adhesive and elastic, general purpose, wide range of available colors; ASTM C 920, Type M, Grade NS, Class 25, Use NT, M, A, G, and O; UL classified; Shore hardness 15-30. Acceptable products:
 - a. Pecora Dynatrol II.
 - b. PRC Permapol RC-2.
 - c. Sikaflex 2c NS.
 - d. Sonneborn Sonolastic NP 2.
 - e. Tremco Vulkem 922 or Dymeric Plus.
 4. **Type C1** - Modified Silicone (Silyl-terminated Polyether) Sealant: One-part, non-sag, low-modulus, high-elongation and compression recovery, highly adhesive, zero VOC, odorless, and non-staining. Acceptable products:
 - a. BASF Sonolastic 150, Sonolastic 150 Tint Base, or equal.
 5. **Type D1a** - Silicone High Performance Sealant: One-part, non-sag, medium-modulus, medium-elongation and compression recovery, highly adhesive, ASTM C 920, Type S, Grade NS, Class 50, Use NT G, M, and O; UL classified. Acceptable products:
 - a. Dow Corning 795.
 - b. GE Silpruf 2000, produced by Momentive Performance Materials.
 - c. Pecora 864.
 - d. Rhône-Poulenc Rhodorsil 3B and 5C.
 - e. BASF Sonolastic Omniseal.
 - f. Tremco Spectrem II.

6. **Type D1b** - Silicone Structural Glazing Sealant: One-part, non-sag, high-modulus, high-elongation and compression recovery, highly adhesive, ASTM C 920, Type S, Grade NS, Class 25, Use NT G, M, and O; UL classified. Acceptable products:
 - a. Dow Corning 983 (two-part).
 - b. GE 4000, produced by Momentive Performance Materials.
 - c. Rhône-Poulenc Rhodorsil 90.
7. **Type D1e** - Silicone Building Sealant: One-part, non-sag, ultra-low-modulus, high-elongation and compression recovery, highly adhesive, ASTM C 920, Type S, Grade NS, Class 100/50, Use T, NT G, M, A, and O; UL 263 classified (ASTM E 119) Fire Tests of Building Construction and Materials. Acceptable products:
 - a. Dow Corning 790.
 - b. GE Weatherseal SCS2700 Silpruf LM, produced by Momentive Performance Materials.
8. **Type D2** - Silicone General Purpose and Sanitary Sealant: One-part, non-sag, primerless, sanitary, and highly flexible, ASTM C 920, Class 25; USDA approved. Acceptable products:
 - a. Dow Corning 786.
 - b. GE SCS1700 Sanitary Sealant, produced by Momentive Performance Materials.
 - c. Pecora 898 or 863.
 - d. Rhône-Poulenc Rhodorsil 6B.
 - e. BASF Sonolastic OmniPlus.
9. **Type E1** - Acrylic Terpolymer Sealant: One-part, non-sag, highly adhesive and elastic; FS TT-S-00230. Acceptable products:
 - a. Pecora 60+ Unicrylic.
 - b. Tremco Mono.
10. **Type E2** - Acrylic Latex Sealant: One-part non-sag; ASTM C 834. Acceptable products:
 - a. GE RCS20, produced by Momentive Performance Materials.
 - b. Pecora AC-20.
 - c. PTI 738.
 - d. Sonneborn Sonolac.
 - e. Tremco Acrylic Latex 824.
11. **Type F1** - Butyl General Purpose Sealant: One-part, non-sag; FS TT-S-1657, Type 1, gun grade. Acceptable products:
 - a. Pecora BC-158.
 - b. PTI 707.
 - c. Tremco Butyl.
12. **Type F2** - Highly resilient, permanently flexible, shrink and stain resistant. Acceptable products:
 - a. GE RCS20, produced by Momentive Performance Materials.
 - b. Ohio Sealants' OSI Pro-Series SC-175 Sound Sealant, VOC-compliant, white waterbase sealant for concealed locations.
 - c. Tremco Acoustical Sealant, black synthetic rubber material for concealed locations only.
 - d. U.S. Gypsum Acoustical Sealant, white waterbase material suitable of exposed or concealed locations, but not waterproof.

13. **Type K1** - Self-Adhesive Sponge Neoprene Pads: Compressible closed cell Polyvinyl Chloride foam or neoprene sponge, 8 pcf to 12 pcf density, self-adhering, for use as filler and acoustical seal in gaps of slip joints, set in place with 10% to 15% compression. Acceptable products:
 - a. Norseal Type V760 Foam Sealants with firm, high-density foam for vibration damping with adhesive on one side, manufactured by Saint-Gobain Performance Plastics, or equal by D.S. Brown Company.
 - b. Norseal Type V980/V990 closed cell PVC Foam Sealants with pressure-sensitive adhesive on both sides, manufactured by Saint-Gobain Performance Plastics, or equal by D.S. Brown Company.
 - c. Norprene Profile custom-designed thermoplastic elastomer foam Extrusions compressible foam tapes adhesive-coated on one side, manufactured by Saint-Gobain Performance Plastics, or equal by D.S. Brown Company.
14. **Type K2** - Self Adhesive Bubble Gaskets: Nominal 1/4-inch x 1/2-inch compressible bulb of silicone rubber or polyprene with self-adhesive on one side. Acceptable Products:
 - a. 5050 Self-Adhesive Gasket by National Guard Products, Memphis, TN, www.ngpinc.com.
 - b. S88D or S88W Siliconseal by Pemko, Ventura, CA, www.pemko.com.
 - c. 797 or 797W by Reese Enterprises, Huntington Beach, CA, www.reeseusa.com.
15. [Type K2 - Acoustical Putty: See Paragraph 2.05-B.3.](#)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 1. Examine joints to be sealed for construction defects which would adversely affect execution of work.
 2. Do not start work until ambient conditions are satisfactory.
 3. Perform sealing before final coats of paint are applied.

3.02 PREPARATION

- A. Protection: Mask areas of contiguous finish.
- B. Surface Preparation:
 1. Cleaning: Clean joint surfaces, using appropriate mechanical means, and using joint cleaner as recommended by sealant manufacturer to remove dust, dirt, oil, grease, rust, laitance, and release agents that might adversely affect adhesion of sealant.
 2. Priming: Apply primer only as directed by sealant manufacturer.
 3. Prepare joint no more than 8 hours prior to application of sealants.

3.03 APPLICATION

- A. General: Comply with sealant manufacturer's printed instructions regarding joint size limitation and geometry, mixing, priming, and application.

- B. Install backing in continuous lengths without interruption. Do not turn backing around corners. Butt lengths together tightly with crowd-in at all corners or changes in plane.
 - 1. Install backing so that joint depth is 50 percent of joint width, but no less than 1/4-inch deep. Install backer in full sections from corner to corner with crowd-in.
- C. Apply sealant in joints using pressure gun with nozzle cut to fit joint width. Make sure sealant is deposited in uniform, continuous beads without gaps or air pockets.
 - 1. Within 10 minutes of sealant application, tool joints to required configuration as a separate operation to fill joints and provide a smooth surface. If masking materials are used, remove immediately after tooling.
- D. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joint.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Concave Joints at Locations Indicated on Contract Drawings: Provide concave joint configuration in accordance with ASTM C 1193 Figure 5A.
 - 4. Flush Joints at Locations Indicated on Contract Drawings: Provide flush joint configuration in accordance with ASTM C 1193 Figure 5B.
 - 5. Recessed Joints at Locations Indicated on Contract Drawings: Provide recessed joint configuration in accordance with ASTM C 1193 Figure 5C, with recess depth indicated.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- E. Apply acoustical sealant on, around, and between building construction members such as framing, panel boxes, cutouts for penetrations of other materials or equipment, and where walls and floors are designated to be sound-attenuating or acoustically treated.
- F. Install joint gasket material of the proper thickness and width to fill space completely and neatly.
 - 1. Do not allow spillage or migration of primer onto adjoining exposed surfaces.
 - 2. Install joint sealer/expansion Joint material in accordance with the manufacturer's instructions.
- G. Install compressible gasketing tape material of the proper thickness and width to fill space completely and neatly with an in-place compression of 10% to 15%.
- H. Paving: Provide light dusting of No. 60 silica sand at all expansion/control joints in building and paving.

3.04 FIELD QUALITY REQUIREMENTS

- A. Perform preconstruction tests of sealants for adhesion and compatibility with all adjacent substrates and accessory components. Submit results of tests with a certification letter from the sealant manufacturer listing the successful results with any recommendations.
- B. Perform periodic field testing as recommended by sealant manufacturer. Submit results stating location and date performed to the Architect for review.

3.05 CLEANING

- A. Remove excess materials adjacent to joints by mechanical means or with xylol (xylene) or mineral spirits as work progresses to eliminate evidence of spillage or damage to adjacent surfaces.
 - 1. Leave finished work in neat, clean condition with no evidence of spillovers onto adjacent surfaces.

END OF SECTION

- SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Translucent and opaque roller shades systems for solar control and room darkening.
 - 1. Manual type operation.
- B. Referenced Sections:
 - 1. Section 012500 - Substitution Procedures.
 - 2. Section 013300 - Submittal Procedures.
 - 3. Section 061000 - Rough Carpentry: Wood blocking for support of roller shade brackets, and roller shade pockets.
 - 4. Section 085113 - Windows.
 - 5. Section 092216 - Non-Structural Metal Framing: Backing for support of roller shade brackets, and roller shade pockets.
 - 6. Section 092900 - Gypsum Board: Coordination with gypsum board assemblies for installation of shade pockets, closures, and related accessories.
 - 7. Section 095100 - Acoustical Ceilings: Coordination with acoustical ceiling systems for installation of shade pockets, closures, and related accessories.
 - 8. Section 095300 - Acoustical Ceiling Suspension Assemblies: Coordination with acoustical ceiling systems for installation of closures and related accessories.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. E 84-12c - Test Method for Surface Burning Characteristics of Building Materials.
 - 2. E 162-13 - Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
 - 3. G 21-13 - Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- B. California Code of Regulations (CCR):
 - 1. Title 19 - Public Safety:
 - a. Division 1 - State Fire Marshal:
 - 1) Chapter 1 - General Fire and Panic Safety Standards:
 - a) Subchapter 1 - Administration:
 - (1) Article 3 - General Provisions:
 - (a) Section 3-08 - Decorative Materials.

2. Title 24, Part 2- California Building Code (CBC), 2013 edition:
 - a. Chapter 11B - Accessibility to Public Buildings, Public Accommodations, Commercial Buildings, and Public Housing:
 - 1) Division 3 - Building Blocks.
 - a) Section 11B-308 - Reach Ranges.
 - b) Section 11B-309 - Operable Parts.
 - (1) 11B-309.4 - Operation.
 - C. National Fire Protection Association (NFPA):
 1. 701 - Standard Methods of Fire Tests for Flame-Resistant Textiles and Films.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate penetrations and ceiling-mounted items.

1.04 SUBMITTALS

- A. General: Make submittals in accordance with provisions of Section 013300.
- B. Product Data: Submit complete manufacturer's descriptive literature and specifications. Include:
 1. Preparation instructions and recommendations.
 2. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
 3. Storage and handling requirements and recommendations.
 4. Mounting details and installation methods.
- C. Shop Drawings: Submit plans, elevations, sections, details of installation, operational clearances, wiring diagrams, and relationship to adjoining work, indicating:
 1. Shade schedule coordinating room number, window type, opening sizes, quantities, and key to details. Use same room designations indicated on Drawings.
 2. Shade layout, seam, and batten locations.
 3. Overall arrangement of shades and control locations.
 4. Details as necessary to coordinate work with surrounding conditions and construction.
- D. Samples: Submit the following for each color and texture required.
 1. Selection Samples: Submit:
 - a. Shade cloth fabric swatches for initial fabric color selection from manufacturer's full range of available fabrics.
 - b. Standard aluminum finish color samples from manufacturer's range of standard and custom colors.
 2. Verification Samples: One fully operational window shade sample of each type required complete with selected sample colors including sample of seam and batten when applicable.
- E. Quality Control Submittals:
 1. Test Reports: Submit certified independent laboratory test reports confirming physical characteristics of materials used in the performance of the work of this Section.
 2. Certification: Submit certification showing independent test calculations that compartments comply with NFPA 701 for Class B requirements.

- F. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.

1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Materials:
1. Furnish the following additional spare materials as Owner's maintenance stock:
 - a. Additional 5 percent of the total length of qualified stainless steel chain required on the project, not to exceed 100 feet.
 - b. Additional 5 percent of each type of shade mounting hardware or brackets, but not less than one pair of each type.
 - c. A quantity of replacement shade bands completely fabricated and ready to attach to roller tubes equal to 5 percent of the total number of shade bands of each fabric and each color in the largest size required for each of those fabrics.
 2. Clearly label spare components and supply to Owner upon completion in original packaging for storage on site by Owner.

1.06 QUALITY ASSURANCE

- A. Qualifications:
1. Manufacturer: A minimum of 20 years experience manufacturing products comparable to those specified in this Section.
 2. Installer: Trained and certified by the manufacturer with a minimum of 10 years experience in installing products comparable to those specified in this Section.
- B. Field Samples:
1. Provide field sample of one typical manual roller shade assembly for evaluation of mounting, appearance (color, weave, and density), accessories, and quality of workmanship.
 2. Locate field sample at window designated by Architect.
 3. Do not proceed with remaining work until field sample is accepted by Architect.
 4. Accepted field samples may become part of the completed work to serve as a standard of workmanship.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades to project in labeled protective packaging. Uniquely labeled to identify each shade for each opening. Schedule delivery to prevent delays to completion of work but to minimize on site storage time.

1.08 FIELD CONDITIONS

- A. Ambient Conditions: Install roller shades after finish work including painting is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Dimensions: Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate construction of surrounding conditions to allow for timely field dimension verification.

1.09 WARRANTY

- A. Special Warranty:
 - 1. EcoVeil Shadecloth: Manufacturer's standard non-depreciating 10-year warranty.
 - 2. Hardware and Chain Warranty: Manufacturer's standard non-depreciating 25-year limited warranty.
 - 3. Installation: One year from date of Substantial Completion, not including scaffolding, lifts, or other means to reach inaccessible areas.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Roller Shade Manufacturers:
 - 1. Draper Shade and Screen Company, Inc., Spiceland, IN (317)987-7999.
 - 2. MechoShade Systems, Inc., Long Island City, NY (718)729-2020, with offices in Los Angeles, CA (310)370-8012, www.mechoshade.com.
 - 3. Skyco Shading Systems, Inc., Santa Ana, CA (714)708-3038, (800)777-5926, www.skycoshade.com.
 - 4. Vimco Shading Systems, a Subsidiary of Lutron, Richmond, Virginia (804)266-9638, (800)446-1503, www.vimco.com.
- B. Like materials shall be the products of one manufacturer and shall be either the ones upon which the design is based or equal products of other manufacturers accepted in advance in accordance with Section 012500.

2.02 REGULATORY REQUIREMENTS

- A. Regulations: Comply with applicable codes and regulations of governmental agencies having jurisdiction.
 - 1. Materials used in this Section shall be tested, listed, and labeled for flammability, combustibility, and smoke developed by a testing agency acceptable by the to the authority having jurisdiction.
 - a. Conform to ASTM E 84, ASTM E 162, and NFPA 701 for large and small scale requirements.
 - 2. Manual shades shall be operable with one hand and shall not require tight grasping, pinching or twisting of the wrist. The force required to activate controls shall be no greater than 5 pounds of force in accordance with CBC 11B-309.4.
 - a. Allowable reach ranges shall be in accordance with CBC Section 11B-308 - Reach Ranges.
 - 3. Comply with Decorative Materials requirements of CCR Title 19 Division 1, Chapter 1, Subchapter 1, Article 3, Section 3-08.
 - 4. Comply with CBC Section 803.1 for flame spread and smoke developed classifications based on building location and group classification when tested in accordance with ASTM E 84, ASTM D 635, and ASTM D 1929.

2.03 PERFORMANCE CRITERIA

- A. Performance Requirements: Provide shade fabrics meeting Class B material fire rating.
 - 1. Fire: Shade fabrics shall be tested in accordance with NFPA 701 large and small scale vertical burn test shall be rated Pass.
 - a. Conform to ASTM E 84, ASTM E 162, and NFPA 701 for large and small scale requirements.
 - 2. Surface Burning Characteristics:
 - a. Flame spread index: 25 or less.
 - b. Smoke developed index: 450 or less.
 - 3. Toxicity: Shade fabrics shall be successfully tested in accordance with University of Pittsburgh Toxicity Protocol, including LC50 analysis and toxicity characteristics.
 - 4. Anti-microbial:
 - a. Results for ATCC6538 (*Staphylococcus aureus*) and ATCC13388 (*Pseudomonas aeruginosa*) indicating minimum 0.197 inches (5mm) No Growth Contact Area.
 - b. Results for ATCC9642, ATCC9644, ATCC9348 and ATCC9645 indicating No Growth in accordance with ASTM G 21.
 - 5. Fabric shall be tensioned in the finishing stage prior to heat setting to keep the warp ends straight and minimize or eliminate weave distortion to keep fabric flat. Finish with heat and pressure.

2.04 SYSTEM TYPES

- A. Design details are based on roller shade products manufactured by MechoShade Systems, Inc., or equal.
- B. Manually Operated Single Shade:
 - 1. Mounting: Surface mounted with pocket.
 - 2. Configuration: Single solar shade cloth.
 - 3. Solar Shade cloths:
 - a. Fabric: Equal to Mechoshade EcoVeil 1550, TPO fabric, non-PVC basket-weave pattern at 3 percent open.
 - b. Color: As indicated in Contract Documents.

2.05 SHADE CLOTH

- A. General:
 - 1. Fabric shall be tensioned in the finishing stage prior to heat setting to keep the warp ends straight and minimize or eliminate weave distortion to keep fabric flat. Finish with heat and pressure.
 - 2. Fire Retardancy: Refer to Article 2.03-A.1 Performance Criteria.

2.06 SHADE BANDS

- A. Shade Bands: Construction of shade band includes the fabric, the hem weight, hem-pocket, shade roller tube, and the attachment of the shade band to the roller tube. Sewn hems and open hem pockets are not acceptable.
 - 1. Hem Pockets and Hem Weights: Fabric hem pocket with RF-welded seams (including welded ends) and concealed hem weights. Hem weights shall be of appropriate size and weight for shade band. Hem weight shall be con-

tinuous inside a sealed hem pocket. Hem pocket construction and hem weights shall be similar, for all shades within one room.

2. Shade Band and Shade Roller Attachment:
 - a. Use extruded aluminum shade roller tube of a diameter and wall thickness required to support shade fabric without excessive deflection. Roller tubes less than 1.55 inch in diameter for manual shades are not acceptable.
 - b. Provide for positive mechanical engagement with drive/brake mechanism.
 - c. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable/replaceable with a snap-on/snap-off spline mounting, without having to remove shade roller from shade brackets.
 - d. Mounting spline shall not require use of adhesives, adhesive tapes, staples, and/or rivets.
 - e. Any method of attaching shade band to roller tube that requires the use of: adhesive, adhesive tapes, staples, and/or rivets is not acceptable.

2.07 COMPONENTS

- A. Access and Material Requirements:
 1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.
 2. Provide shade hardware that allows for removal and re-mounting of the shade bands without having to remove the shade tube, drive or operating support brackets.
 3. Use only Delrin engineered plastics by DuPont for all plastic components of shade hardware. Styrene based plastics, and /or polyester, or reinforced polyester will not be acceptable.
- B. Operated Chain Drive Hardware and Brackets for Manual Operation:
 1. Provide for universal, regular and offset drive capacity, allowing drive chain to fall at front, rear or non-offset for all shade drive end brackets. Universal offset shall be adjustable for future change.
 2. Provide hardware capable for installation of a removable fascia, for both regular and/or reverse roll, which shall be installed without exposed fastening devices of any kind.
 3. Provide shade hardware system that allows for removable regular and/or reverse roll fascias to be mounted continuously across two or more shade bands without requiring exposed fasteners of any kind.
 4. Provide shade hardware system that allows for operation of multiple shade bands (multi-banded shades) by a single chain operator, subject to manufacturer's design criteria. Connectors shall be offset to assure alignment from the first to the last shade band.
 5. Provide shade hardware system that allows multi-banded manually operated shades to be capable of smooth operation when the axis is offset a maximum of 6 degrees on each side of the plane perpendicular to the radial line of the curve, for a 12 degrees total offset.

6. Provide positive mechanical engagement of drive mechanism to shade roller tube. Friction fit connectors for drive mechanism connection to shade roller tube are not acceptable
7. Provide shade hardware constructed of minimum 1/8-inch thick plated steel or heavier as required to support 150 percent of the full weight of each shade.
8. Drive Bracket / Brake Assembly:
 - a. MechoShade Drive Bracket model M5 shall be fully integrated with all MechoShade accessories, including, but not limited to: SnapLoc fascia, room darkening side / sill channels, center supports and connectors for multi-banded shades.
 - b. M5 drive sprocket and brake assembly shall rotate and be supported on a welded 3/8 inch steel pin.
 - c. The brake shall be an over-running clutch design which disengages to 90 percent during the raising and lowering of a shade. The brake shall withstand a pull force of 50 lbs. in the stopped position.
 - d. The braking mechanism shall be applied to an oil-impregnated hub on to which the brake system is mounted. The oil impregnated hub design includes an articulated brake assembly, which assures a smooth, non-jerky operation in raising and lowering the shades. The assembly shall be permanently lubricated. Products that require externally applied lubrication and or not permanently lubricated are not acceptable.
 - e. The entire M5 assembly shall be fully mounted on the steel support bracket, and fully independent of the shade tube assembly, which may be removed and reinstalled without effecting the roller shade limit adjustments.
 - f. Drive Chain: #10 qualified stainless steel chain rated to 90-pound minimum breaking strength. Nickel plate chain shall not be accepted.

2.08 ACCESSORIES

- A. Fascia:
 1. Continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.
 2. Fascia shall be able to be installed across two or more shade bands in one piece.
 3. Fascia shall fully conceal brackets, shade roller and fabric on the tube.
 4. Provide bracket/fascia end caps where mounting conditions expose outside of roller shade brackets.
 5. Notching of Fascia for manual chain shall not be acceptable.
- B. Brackets: Designed for easy removal and reinstallation of shade, for supporting roller, and operating hardware and for hardware position and shade mounting method indicated.
- C. Fasteners: Not fewer than two fasteners per bracket, fabricated from metal non-corrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

- D. Guide Cables: Provide manufacturer's standard guide cables, aluminum mounting blocks, clevis connectors, and hooks as required to control shades at sloping walls.

2.09 FABRICATION

- A. Fabricate units to completely fill existing openings from head to sill and jamb-to-jamb, unless specifically indicated otherwise.
 - 1. Comply with manufacturer's edge clearance standards and recommendations.
 - 2. Shades shall be fabricated from a single roll of fabric without seams.
- B. Fabricate shade cloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shade cloth to roll true and straight without shifting sideways more than 1/8 inch in either direction per 8 feet of shade height due to warp distortion or weave design. Fabricate hem as follows:
 - 1. Bottom hem weights.
 - 2. Concealed hemtube.
 - 3. Exposed hemtube.
 - 4. Exposed blackout hembar with light seal.
 - 5. Exposed blackout hembar with polybond seal.
 - 6. Exposed tube hem bar with wire guides support for lecture halls.
 - 7. Concealed weight hem bar for all other shades.
- C. Provide battens in standard shades as required to ensure proper tracking and uniform rolling of the shade bands. Contractor shall be responsible for ensuring that the width-to-height (W:H) ratios shall not exceed manufacturer's standards or, in absence of such standards, Contractor shall be responsible for establishing appropriate standards to ensure proper tracking and rolling of the shade cloth within specified standards. Battens shall be roll-formed stainless steel or tempered steel, as required.
- D. Shades shall be railroaded. Provide seams in railroaded multi-width shade bands as required to meet size requirements and in accordance with seam alignment as acceptable to Architect. Seams shall be properly located. Furnish battens in place of plain seams when the width, height, or weight of the shade exceeds manufacturer's standards. In absence of such standards, ensure proper use of seams or battens as required to, and ensure the proper tracking of the railroaded multi-width shade bands.
 - 1. Double hem shades having different colors on outside and inside.
- E. Blackout Shade Bands: When used in side channels, blackout shade bands shall have horizontally mounted, roll-formed stainless steel or tempered-steel battens not more than 3 feet on centers extending fully into the side channels. Battens shall be concealed in a integrally-colored fabric to match the inside and outside colors of the shade band, in accordance with manufacturer's published standards for spacing and requirements.
 - 1. Battens shall be roll formed of stainless steel or tempered steel and concave to match the contour of the roller tube.
 - 2. Batten pockets shall be self-colored fabric front and back RF welded into the shade cloth. A self-color opaque liner shall be provided front and back to eliminate any see through of the batten pocket that shall not

exceed 1-1/2 inches high and be totally opaque. A see-through moire effect, which occurs with multiple layers of transparent fabrics, is not acceptable.

- F. Hembars and Hempockets: Fabric hempocket with RF-welded seams (including welded ends) and concealed hemweights. Hemweights shall be of appropriate size and weight for shade band and must be continuous inside a sealed hempocket. Match hempocket construction for all shades in same rooms.

2.10 FINISHES

- A. Finishes: Fascia, Closure, and Closure Mounts:
 - 1. Aluminum Components: PPG Duracron baked enamel in standard and custom colors as indicated on the Contract Drawings.
 - 2. Steel Components: Cadmium-plated, satin-finished, or bonderized prior to painting with manufacturer's standard baked-enamel finish in standard and custom colors as indicated on the Contract Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Ensure that painting and other finishing operations have been completed before proceeding with installation. Do not begin installation until substrates have been properly prepared.

3.02 PREPARATION

- A. Surfaces shall be thoroughly cleaned prior to installation.

3.03 INSTALLATION

- A. General: Install materials and systems in accordance with the manufacturer's recommendations, and in proper relation to adjacent construction.
- B. Attach the tracks securely to concealed framing with self-drilling self-tapping steel screws.
- C. Install roller shades level, plumb, square, and true. Allow clearances for window operation hardware, and located so shade band is not closer than 2 inches to interior face of glass. Allow proper clearances for window operation hardware.
 - 1. Maximum Variation of Gap at Window Perimeter: 1/4-inch per 8 feet \pm 1/8-inch of shade height.
 - 2. Maximum Offset from Level: 1/16-inch per 5 feet of shade width.
- D. Fabric shall hang flat, without buckling or distortion. The edges shall hang straight without raveling. An unguided roller shade cloth shall roll true and straight, without shifting sideways more than 1/8-inch in either direction due to warp distortion, or weave design.

3.04 ADJUSTING

- A. Adjusting: Adjust roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.
 - 1. Touch-up, repair or replace damaged products before Substantial Completion.

3.05 CLEANING

- A. Cleaning: Clean roller shade surfaces after installation, according to manufacturer's recommendations.
- B. Remove finger marks, smears, and other visual soiling from exposed surfaces upon completion of the installation. Take care not to damage the fabric when cleaning it.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

3.07 PROTECTION

- A. Protect installed products until completion of project.

END OF SECTION

- SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 1. Isolation pads.
 2. Isolation mounts.
 3. Restrained elastomeric isolation mounts.
 4. Freestanding and restrained spring isolators.
 5. Housed spring mounts.
 6. Elastomeric hangers.
 7. Spring hangers.
 8. Spring hangers with vertical-limit stops.
 9. Pipe riser resilient supports.
 10. Resilient pipe guides.
 11. Seismic snubbers.
 12. Restraining braces and cables.

1.03 DEFINITIONS

- A. CBC: California Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.04 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 1. Seismic-Restraint Loading: Refer to Structural Drawings.
 2. Hangers , supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in ASCE/SEI 7-05, Chapter 13
 3. Assigned Seismic Use Group or Building Category as Defined in the CBC: .See Structural Drawings and Specification.
 - a. Component Importance Factor: .See Structural Drawings and Specification.
 - b. Component Response Modification Factor: .See Structural

Drawings and Specification.

- c. Component Amplification Factor: .See Structural Drawings and Specification.
4. Design Spectral Response Acceleration at Short Periods (0.2 Second): .See Structural Drawings and Specification.
5. Design Spectral Response Acceleration at 1-Second Period: .See Structural Drawings and Specification.

1.05 SUBMITTALS

- A. Product Data: For the following:
 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Coordination Drawings: Show coordination of seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- C. Welding certificates.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproved by ICC-ES, or preapproved by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support

seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries or a comparable product by one of the following:
 - 1. Ace Mountings Co., Inc.
 - 2. Amber/Booth Company, Inc.
 - 3. California Dynamics Corporation.
 - 4. Isolation Technology, Inc.
 - 5. Kinetics Noise Control.
 - 6. Mason Industries.
 - 7. Vibration Eliminator Co., Inc.
 - 8. Vibration Isolation.
 - 9. Vibration Mountings & Controls, Inc.
- B. Pads : Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- C. Mounts : Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- D. Restrained Mounts : All-directional mountings with seismic restraint.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- E. Spring Isolators : Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- F. Restrained Spring Isolators : Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- G. Housed Spring Mounts : Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 2. Base: Factory drilled for bolting to structure.
 3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.
- H. Elastomeric Hangers : Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- I. Spring Hangers : Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Self-centering hanger rod cap to ensure concentricity between

hanger rod and support spring coil.

- J. Spring Hangers with Vertical-Limit Stop <Insert drawing designation> : Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 - 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- K. Pipe Riser Resilient Support : All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-(13-mm-) thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.
- L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch-(13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.02 VIBRATION ISOLATION EQUIPMENT BASES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries or a comparable product by one of the following:
 - 1. Amber/Booth Company, Inc.
 - 2. California Dynamics Corporation.
 - 3. Isolation Technology, Inc.
 - 4. Kinetics Noise Control.
 - 5. Mason Industries.
 - 6. Vibration Eliminator Co., Inc.
 - 7. Vibration Isolation.
 - 8. Vibration Mountings & Controls, Inc.
- B. Steel Base : Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

- a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Inertia Base : Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.03 SEISMIC-RESTRAINT DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide MASON Industries or a comparable product by one of the following:
1. Hilti, Inc.
 2. Mason Industries.
 3. TOLCO Incorporated; a brand of NIBCO INC.
 4. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.
- D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with

corrosion-resistant coating; and rated in tension, compression, and torsion forces.

- E. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.04 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment Restraints:
 - 1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inches.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 Section "Domestic Water Piping" for piping flexible connections.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
1. Comply with California Division of the State Architect (DSA) Interpretation of Regulations IR 19-1: Post Installed Anchors in Concrete.
- C. Tests and Inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.

5. Test to 90 percent of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.
 9. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 10. Air-Mounting System Operational Test: Test the compressed-air leveling system.
 11. Test and adjust air-mounting system controls and safeties.
 12. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
 - E. Prepare test and inspection reports.

3.06 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of sprint isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION

- SECTION 220700 -

PLUMBING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Flexible elastomeric.
 - b. Mineral fiber.
 - c. Polyolefin.
 - 2. Adhesives.
 - 3. Sealants.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Qualification Data: For qualified Installer.
- C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- D. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

A. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Aeroflex USA Inc.; Aerocel.
- b. Armacell LLC; AP Armaflex.
- c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

E. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Fibrex Insulations Inc.; Coreplus 1200.
- b. Johns Manville; Micro-Lok.
- c. Knauf Insulation; 1000(Pipe Insulation.
- d. Manson Insulation Inc.; Alley-K.
- e. Owens Corning; Fiberglas Pipe Insulation.

- F. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armacell LLC; Tubolit.
 - b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
 - c. RBX Corporation; Therma-cell.

2.02 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aero seal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.03 SEALANTS

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.

3. Service Temperature Range: Minus 100 to plus 300 deg F .
 4. Color: White or gray.
 5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F .
 5. Color: Aluminum.
 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F .
 5. Color: White.
 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer

- 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F . Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
 - D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches . Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - 4. For below ambient services, apply vapor-barrier mastic over staples.
 - 5. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications

- requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches .
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
- F. Comply with requirements for firestopping and fire-resistive joint sealers listed in other sections.
- G. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements for firestopping and fire-resistive joint sealers listed in other sections.

3.05 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the

- insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to

surface being insulated.

- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 - 4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of

- pipe insulation when available.
 - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
- 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.

3.08 POLYOLEFIN INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
- 1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
- 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
- 1. Install mitered sections of polyolefin pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
- 1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
 - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.09 FINISHES

- A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
- 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to

render fabric mildew proof.

- a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 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 field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water:
 1. NPS 1-1/4 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 2. NPS 1-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Condensate and Equipment Drain Water below 60 Deg F :

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Polyolefin: 1 inch thick.

END OF SECTION

- SECTION 221005 -

- PLUMBING PIPING -

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Pipe, pipe fittings, valves, and connections for piping systems.
 - 1. Sanitary sewer.
 - 2. Sanitary Vent.
 - 3. Domestic water.
 - 4. Storm water.
 - 5. Gas.
 - 6. Indirect and Condensate

1.02 RELATED REQUIREMENTS

- A. Section 31 2316 - Excavation.
- B. Section 31 2323 - Fill.
- C. Section 31 2316.13 - Trenching.
- D. Section 33 1300 - Disinfecting of Water Utility Distribution.
- E. ~~Section 07 8400 - Firestopping~~. Not used.
- F. Section 08 3100 - Access Doors and Panels.
- G. Section 09 9100 - Painting
- H. Section 09 9600 - Coating.
- I. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- J. Section 22 0553 - Identification for Plumbing Piping and Equipment.
- K. Section 22 0719 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

- A. ANSI Z21.22 - American National Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems; 1999, and addenda A&B (R2004).
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; The American Society of Mechanical Engineers; 2011.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2012 (ANSI B16.18).

- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2013.
- E. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; The American Society of Mechanical Engineers; 2011.
- F. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; The American Society of Mechanical Engineers; 2012.
- G. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2011 (ANSI/ASME B31.9).
- H. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2013.
- I. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- J. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2013a.
- K. ASTM B32 - Standard Specification for Solder Metal; 2008.
- L. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes; 2010.
- M. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2013.
- N. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).
- O. AWWA C651 - Disinfecting Water Mains; American Water Works Association; 2005 (ANSI/AWWA C651).
- P. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2009.
- Q. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2011
- R. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2012.
- S. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2012.
- T. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2013.
- U. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Product Origin: Each pipe and fitting shall be marked with the following: Manufacturer's name or registered trademark, Country of Origin, date of manufacture (pipe materials only).
- D. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
- D. Welder Qualifications: Certified in accordance with ASME (BPV IX).
- E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.
- F. Made in USA: All piping products shall be manufactured and fabricated in the United States and produced from materials that is made and melted in the United States.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 - PRODUCTS

2.01 SANITARY SEWER AND VENT PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Hubless Cast Iron Pipe and Fittings:
 - 1. Pipe Fittings: ASTM A 888 or CISPI 301.
 - 2. Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.
 - 3. Shielded Couplings: ASTM C 1540 assembly of metal shield or housing, corrosion-resistant fasteners and rubber sleeve with integral, center pipe stop.
 - a. Sanitary Sewer And Vent Piping - Heavy-Duty, 4-band shielded, stainless-steel couplings, with stainless-steel corrugated shield;

stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

2.02 SANITARY SEWER AND VENT PIPING, ABOVE GRADE

- A. Hubless Cast Iron Pipe and Fittings:
 - 1. Pipe Fittings: ASTM A 888 or CISPI 301.
 - 2. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners and rubber sleeve with integral, center pipe stop.
 - a. Vent Piping - Standard, 2-band or 4-band shielded, stainless-steel couplings, CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
 - 3. Shielded Couplings: ASTM C 1540 assembly of metal shield or housing, corrosion-resistant fasteners and rubber sleeve with integral, center pipe stop.
 - a. Sanitary Sewer Piping - Heavy-Duty, 4-band shielded, stainless-steel couplings, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

2.03 WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Copper Tube and Fittings:
 - 1. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B 16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Soft Copper Tube: ASTM B88, Type K water tube, annealed temper.
 - 1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.04 WATER PIPING, ABOVE GRADE

- A. Copper Tube and Fittings:
 - 1. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B 16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.05 CONDENSATE PIPING

- A. Copper Tube And Fittings:
 - 1. Hard Drawn Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 - 2. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

2.06 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 - 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 - 4. Vertical Pipe Support: Steel riser clamp.
- B. Plumbing Piping - Drain, Waste, and Vent:
 - 1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 3. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 - 4. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
- C. Plumbing Piping - Water:
 - 1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 3. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- D. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - 4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.

2.07 BRONZE GATE VALVES

- A. Bronze Gate Valve, General: MSS SP-80, with ferrous-alloy handwheel.
- B. Type 2, Class 200, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge and union-ring bonnet.

2.08 RELIEF VALVES

- A. Pressure Relief:
 - 1. AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.
- B. Temperature and Pressure Relief:
 - 1. AGA Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME (BPV IV) certified and labelled.

2.09 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers:
 - 1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.

2. Body: Bronze for NPS 2 inch and smaller. Cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating for NPS 2-1/2 inch and larger.
3. End Connections: Threaded for NPS 2 inch and smaller. Flanged for NPS 2-1/2 inch and larger.
4. Screen: Stainless steel with round perforations, unless otherwise noted.
5. Perforation Size:
 - a. Strainers NPS 2 inch and Smaller: 0.062 inch (157 mm)
 - b. Strainers NPS 2-1/2 inch to NPS 4 inch: 0.125 inch (3.18 mm).
 - c. Strainers NPS 5 inch and Larger: 0.25 inch (6.35 mm)
6. Drain: Factory-installed, hose-end drain valve.

2.10 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 1. Standard: ASSE 1001.
 2. Size: NPS 1/4 to NPS 3 inch, as required to match connected piping.
 3. Body: Bronze.
 4. Inlet and Outlet Connections: Threaded.
 5. Finish: Chrome Plated.
- B. Pressure Vacuum Breakers:
 1. Standard: ASSE 1020.
 2. Operation: Continuous-pressure Applications.
 3. Accessories:
 - a. Valves: Ball Type, on inlet and outlet.

2.11 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. Operating-Pressure Rating: 0.5 psig.
 5. End Fittings: Zinc-coated steel.
 6. Threaded Ends: Comply with ASME B1.20.1.
 7. 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 and smaller; flanged ends for NPS 2-1/2 and larger.
 3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 4. CWP Rating: 125 psig
- C. Basket Strainers:
 1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 4. CWP Rating: 125 psig
- D. T-Pattern Strainers:
1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
 2. End Connections: Grooved ends.
 3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
 4. CWP Rating: 750 psig
- E. 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

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 0719.
- H. Provide access where valves and fittings are not exposed.
- I. Establish elevations of buried piping outside the building to ensure not less than 2 ft of cover.
- J. Install vent piping penetrating roofed areas to maintain integrity of roof assembly;

- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Provide support for utility meters in accordance with requirements of utility companies.
- M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 9000.
- N. Excavate in accordance with Division 31.
- O. Backfill in accordance with Division 31.
- P. Install bell and spigot pipe with bell end upstream.
- Q. Install valves with stems upright or horizontal, not inverted.
- R. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
- S. Install water piping to ASME B31.9.
- T. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- U. Sleeve pipes passing through partitions, walls and floors.
- V. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- W. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping.
 - 9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - 10. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 22 0548.

11. Support cast iron drainage piping at every joint.

3.04 APPLICATION

- A. Use grooved mechanical couplings and fasteners only in accessible locations.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- D. Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Install globe valves for throttling, bypass, or manual flow control services.
- F. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- G. Provide spring loaded check valves on discharge of water pumps.
- H. Provide plug valves in natural gas systems for shut-off service.
- I. Provide flow controls in water recirculating systems where indicated.

3.05 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.
- B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfect water distribution system in accordance with Division 31.
- B. Prior to starting work, verify system is complete, flushed and clean.
- C. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- D. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- E. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- F. Maintain disinfectant in system for 24 hours.
- G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- H. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- I. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.07 SCHEDULES

- A. Pipe Hanger Spacing:
 - 1. Metal Piping:
 - a. Pipe size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum hanger spacing: 6.5 ft.
 - 2) Hanger rod diameter: 3/8 inches.
 - b. Pipe size: 1-1/2 inches to 2 inches:
 - 1) Maximum hanger spacing: 10 ft.
 - 2) Hanger rod diameter: 3/8 inch.
 - 2. Plastic Piping:
 - a. All Sizes:
 - 1) Maximum hanger spacing: 6 ft.
 - 2) Hanger rod diameter: 3/8 inch.

END OF SECTION

- SECTION 221006 -

PLUMBING PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Cleanouts.
- B. Backflow preventers.
- C. Water hammer arrestors.
- D. Thermostatic mixing valves.

1.02 RELATED REQUIREMENTS

- A. Section 22 1005 - Plumbing Piping.
- B. Section 22 4000 - Plumbing Fixtures.
- ~~C. Section 22 3000 - Plumbing Equipment.~~

1.03 REFERENCE STANDARDS

- A. ASME A112.6.3 - Floor and Trench Drains; The American Society of Mechanical Engineers; 2001 (R2007).
- B. ASME A112.6.4 - Roof, Deck, and Balcony Drains; The American Society of Mechanical Engineers; 2003.
- C. PDI-WH 201 - Water Hammer Arresters; Plumbing and Drainage Institute; 2010.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- D. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
- E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 - PRODUCTS

2.01 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation
 - 2. Standard: ASME A112.3.1 for stainless steel for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk, brass plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- B. Metal Floor Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule cleanout.
 - 3. Size: Same as connected branch.
 - 4. Type: Cast-iron soil pipe with cast-iron ferrule.
 - 5. Body or Ferrule:.
 - 6. Clamping Device: Required.
 - 7. Outlet Connection: Inside calk.
 - 8. Closure: Brass plug with tapered threads.
 - 9. Adjustable Housing Material: Cast iron with threads.
 - 10. Frame and Cover Material and Finish: Stainless steel.
 - 11. Frame and Cover Shape: Round.
 - 12. Top Loading Classification: Heavy Duty.
 - 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
 - 14. Standard: ASME A112.3.1.
 - 15. Size: Same as connected branch.
 - 16. Housing: Stainless steel.
 - 17. Closure: Stainless steel with seal.

18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.02 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings

2.03 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- C. Sleeve Flashing Device:
1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches (51 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 2. Size: As required for close fit to riser or stack piping.
- D. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 2. Size: Same as connected stack vent or vent stack.
- E. Vent Caps:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
 2. Size: Same as connected stack vent or vent stack.

2.04 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
 2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.
 3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness.
- B. Fasteners: Metal compatible with material and substrate being fastened.
- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- D. Solder: ASTM B 32, lead-free alloy.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic

2.05 WATER HAMMER ARRESTORS

- A. Manufacturers:
1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
 2. Watts Regulator Company: www.wattsregulator.com.
 3. Zurn Industries, Inc: www.zurn.com.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Water Hammer Arrestors:
1. Stainless steel construction, piston type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psi working pressure.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Install floor cleanouts at elevation to accommodate finished floor.
- E. Install approved portable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
- F. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatories sinks washing machine outlets
_____.

END OF SECTION

- SECTION 230923 -

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. System Description
- B. Operator Interface
- C. Controllers
- D. Power Supplies and Line Filtering
- E. System Software
- F. Controller Software

1.02 REFERENCE STANDARDS

- A. ANSI CEA 709.1.C - Control Network Protocol Specification; 2010.
- B. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2012.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for each system component and software module.
- C. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.

2. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration diskette containing graphics.
 3. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 4. Indicate description and sequence of operation of operating, user, and application software.
- D. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
- E. Operation and Maintenance Data:
1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Design system software under direct supervision of a Professional Engineer experienced in design of this Work and licensed at the State in which the Project is located.
- C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years experience approved by manufacturer.

1.06 WARRANTY

- A. See Section 017700 - Closeout Procedures, for additional warranty requirements.
- B. Correct defective Work within a five year period after Substantial Completion.
- C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

PART 2: PRODUCTS

2.1 MATERIALS

- A Part Includes:
1. Materials
 2. Communication
 3. Operator Workstation
 4. Controller Software

5. Building Controllers
 6. Advanced Application Controllers
 7. Application Specific Controllers
 8. Input/ Output Interface
 9. Power Supplies and Line Filtering
 10. Auxiliary Control Devices
 11. Wiring and Raceways
 12. Fiber Optic Cable System
- B. All products used in this project installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's Representative in writing. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

- A. All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and Operator Workstations) shall conform to ANSI/ASHRAE Standard 135-2001, BACnet.
- B. Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device as defined in this section.
- C. The Contractor shall provide all communication media, connectors, repeaters, bridges, hubs, switches, and routers necessary for the internetwork.
- D. All controllers shall have a communication port for connections with the Operator Workstations using the BACnet Data Link/ Physical layer protocol.
- E. A device on the internetwork shall be provided with a 56k-baud modem that will allow for remote Operator Workstation using the BACnet PTP Data Link/ Physical layer protocol. Remote Operator Workstation via this modem shall allow for communication with any and all controllers on this network as described in Paragraph F below.
- F. Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:
 - 1 Connection of an Operator Workstation device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.
 - 2 All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer

shall not be required to set up any communication services to perform internetwork value passing.

- G. The time clocks in all controllers shall be automatically synchronized daily. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the network.
- H. The network shall have the following minimum capacity for future expansion:
 1. Each Building Controller shall have routing capacity for 99 controllers.
 2. The Building Controller network shall have capacity for 1000 Building Controllers.
 3. The system shall have an overall capacity for 12,500 Building Controller, Advanced Application Controller, and Application Specific Controller input/output objects.

2.3 OPERATOR WORKSTATION

- A. Operator Workstation. Furnish two PC-based workstations as shown on the system drawings. Each of these workstations shall be able to access all information in the system. These workstations shall reside on the same Ethernet protocol network as the Building Controllers.
- B. Workstation information access shall use the BACnet protocol. Communication shall use the ISO 8802-3 (Ethernet) Data Link/ Physical layer protocol.
- C. Hardware. Each operator workstation and custom programming workstation shall consist of the following:
 1. Personal Computer. Furnish IBM compatible PCs as shown. The CPU shall be a minimum of an Intel Pentium and operate at a minimum of 1,800 MHz. A minimum of 1 gigabyte of RAM, one CD readable/writeable drive and a 80GB hard disk with a minimum access time of 12 milliseconds shall be provided. A two-button mouse also will be provided. Furnish all required serial (USB), and network communication ports, and all cables for proper system operation. The PC shall have a minimum of a 20" SVGA LCD monitor (1024 x 768 resolution, 32 Bit color).
 2. Modems. Furnish one auto-dial telephone modem per workstation and associated cables for communication to remote buildings and workstations. The modem shall transmit at a minimum of 56K baud, and communicate over voice-grade telephone lines and comply to BACnet data link Point-To-Point.
 3. Printers. Each workstation shall have one printer equivalent to a Lexmark Z22 color inkjet and associated cables or one laser printer.
 4. BACnet Interoperability Building Blocks. The workstation shall support the following BIBBs:

Data Sharing	Alarm & Event	Scheduling	Trending	Device & Network Mgmt.
DS-RP-A,B	AE-N-A	SCHED-A	T-VMT-A	DM-DDB-A,B
DS-RPM-A	AE-ACK-A		T-ATR-A	DM-DOB-A,B
DS-WP-A	AE-ASUM-A			DM-DCC-A
DS-WPM-A	AE-ESUM-A			DM-TS-A

				DM-UTC-A
				DM-RD-A
				DM-BR-A
				NM-CE-A

D. System Software

1. Operating System. Furnish a concurrent multi-tasking operating system. The operating system also shall support the use of other common software applications that operate under Microsoft Windows. Examples include Microsoft Excel, Microsoft Word, Microsoft Access. Acceptable operating systems are Windows 2000 Professional, Windows XP Pro and Windows 2003 Server.
2. System Graphics. The operator workstation software shall be a graphical user interface (GUI). The system shall allow display of up to 10 dynamic and animated graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on-line. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.
3. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Visio or AutoCad
4. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program. Graphics shall be created by drag-and-drop selection of graphic symbols and drag-and-link with BACnet objects with dynamic and interactive display fields.
5. Multilingual. Software shall be supported in the following languages English, Spanish, French, German, Chinese.
6. Dynamic Data Exchange (DDE). Software shall support dynamic data sharing with other Windows-based programs for third party add-on functionality e.g. preventative maintenance, tenant billing, etc.

E. System Applications. Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation:

1. System Database Save and Restore. Each workstation shall store on the hard disk a copy of the current database of each Building Controller. This

- database shall be updated whenever an operator initiates a save command.
2. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to save the database from any system panel. The operator shall be able to clear a panel database via the network and may initiate a download of a specified database to any panel in the system from the network.
 3. System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection.
 4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
 5. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application.
 6. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers.
 7. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system.
 8. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm, in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.
 9. Alarm Reactions. The operator shall be able to determine (by object) what if any actions are to be taken during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation.
 10. Trend Logs. The operator shall be able to define a custom trend log for any data object in the system. This definition shall include change-of-value digital, change-of-value analog, time interval, start time, and stop time. Trend data shall be sampled and stored on the Building Controller panel, and be archivable on the hard disk and be retrievable for use in spreadsheets and standard database programs.
 11. Alarm and Event Log. The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms.
 12. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object and

property in the system. The status shall be available by menu, on graphics, or through custom programs.

13. Clock Synchronization. The real-time clocks in all building control panels and workstations shall be using the BACnet Time Synchronization service. The system also shall be able to automatically synchronize all system clocks daily from any operator-designated device in the system. The system shall automatically adjust for daylight savings and standard time, if applicable.
- F. Workstation Applications Editors. Each PC workstation shall support editing of all system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at one or more of the controller panels.
1. Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and setpoints for all controllers.
 2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and month. This shall consist of a monthly calendar for each schedule. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a schedule. The start and stop times for each object shall be adjustable from this master schedule.
 3. Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. *The system shall be fully operable while custom routines are edited, compiled, and downloaded.* The programming language shall have the following features:
 - a. The language shall be English language oriented, be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and allow for free-form programming (i.e., not column-oriented or "fill in the blanks").
 - b. A full-screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate word processing features such as cut/paste and find/replace.
 - c. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
 - d. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results. The debugger also shall provide error messages for syntax and execution errors.
 - e. The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

- f. The programming language shall support floating point arithmetic using the following operators: +, -, /, x, square root, and x-to-the-y-power. The following mathematical functions also shall be provided: natural log, log, trigonometric functions (sine, cosine, etc.), absolute value, and minimum/maximum value from a list of values.
 - g. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/THEN comparisons, calculations, etc.
 - h. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.
 - i. The programs shall support online changes with the ability to read real time values without exiting the program. Sample programs and syntax help functions shall be resident in the program.
- F. Portable Operator's Terminal. Furnish a Portable Operator's Terminal that shall be capable of accessing all system data. This device may be connected to any point/object on the system network or may be connected directly to any controller for programming, setup, and troubleshooting. This device may be connected to any point/object on the system network or it may be connected directly to controllers using the BACnet PTP (Point-To-Point) Data Link/ Physical layer protocol. The terminal shall use the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-2001, to communicate with BACnet objects in the internetwork. The Portable Operator's Terminal shall be an IBM compatible notebook-style PC including all software and hardware required. The PC shall contain at minimum:
- 1. 1,800 MHz Pentium Processor
 - 2. 1 Gigabytes of RAM
 - 3. 60GB Hard Drive
 - 4. CD R-W Disk Drive
 - 5. Touch-pad or Other Internal Pointing Device
- G. Report Management:
- 1. The following reporting capability shall be provided at the operator workstation.
 - 2. Reporting:
 - a. Internal reports built into operator workstation software
 - b. External reporting via ODBC
 - 3. Internal Reports
 - a. User definable query reports (support advanced multiple property, multiple object).

- b. Reports shall be scheduled for automatic generation by schedule or event.
- c. Manual execution to printing/file.
- d. Ability to save report in system report folder.
- e. Query controller hierarchy.
- f. Report to multiple destinations
 - i. Email
 - ii. Print
 - iii. File (text, csv, xml)
 - iv. Terminal
- 4. Enterprise Interface
 - a. ODBC driver supporting common SQL statements (select, update, insert, where, order by, group by, etc.)
 - b. Allow integration to Enterprise software
 - c. Shall be capable of being used with third party software that supports ODBC connection such as: Microsoft Access, Excel, Crystal Reports, etc.
 - d. All queries shall be real time into live controller network.
 - e. Shall be able to both read and write using SQL.
- H. Web Browser Interface
 - 1. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™.
 - 2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BAS, shall not be acceptable.
 - 3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
 - 4. The Web browser client shall support at a minimum, the following functions:
 - a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - 5. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - 6. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - 7. Storage of the graphical screens shall be in the Server, without requiring any graphics to be stored on the client machine.
 - 8. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.

9. User's shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 10. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 11. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 12. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
 13. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.
- H. Server functions and hardware:
1. A central server, located per district standards, shall be provided. The server shall support all Network Area Controllers connected to the customer's network whether local or remote. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, T1 or dial-up connection.
 2. The server shall provide scheduling for all Area Controllers and their underlying field control devices.
 3. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers. Systems not employing this prioritization shall not be accepted.
 4. The server shall provide central management of alarm data for all Network Area controllers supported by the server inclusive of the following:
 - a. View and acknowledge alarms
1. Server Hardware Requirements: The server hardware platform shall have the following requirements:
 - a. The computer shall be an Intel Pentium P4 based computer (minimum processing speed of 1.8 GHz with 1 GB RAM and a 100-gigabyte minimum hard drive). It shall include a 32x CD RW Drive, 2 10/100 Ethernet cards, 1024x768 True Color Video Card
 - b. The server operating system shall be Microsoft XP Professional or Microsoft Windows Server 2003.

2.4 CONTROLLER SOFTWARE

- A. Furnish the following applications software for building and energy management. All software applications shall reside and operate in the system controllers. Editing of applications shall occur at the operator workstation

- B. System Security
 - 1. User access shall be secured using individual security passwords and user names.
 - 2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
 - 3. User Log On/Log Off attempts shall be recorded.
- C. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each schedule shall consist of the following:
 - 1. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop and optimal start. Each schedule may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to adjust the start and stop times for each member.
 - 2. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
- D. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions.
- E. Remote Communication. The system shall have the ability to dial out in the event of an alarm using BACnet Point-To-Point at a minimum of 56K baud. Receivers shall be BACnet workstations.
- F. Maintenance Management. The system shall monitor equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits.
- G. Sequencing. Provide application software to properly sequence the start and stop of chillers, boilers, and pumps to minimize energy usage in the facility.
- H. PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, setpoint, and PID gains shall be user-selectable.
- I. Staggered Start. This application shall prevent all controlled equipment from simultaneously restarting after a power outage.
- J. Energy Calculations. Provide software to allow instantaneous power (e.g., kW) or flow rates (e.g., L/s [GPM]) to be accumulated and converted to energy usage data. Provide an algorithm that calculates a sliding-window kW demand value.
- K. Anti-Short Cycling. All binary output objects shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.
- L. On/Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and setpoint. The

algorithm shall be direct-acting or reverse-acting, and incorporate an adjustable differential.

- M. Run-time Totalization. Provide software to totalize run-times for all binary input objects. A high run-time alarm shall be assigned, if required, by the operator.

2.5 BUILDING CONTROLLERS

- A. General. Provide an adequate number of Building Controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these panels shall meet the following requirements.
1. The Energy Management and Control System shall be comprised of one or more independent, standalone, microprocessor-based Building Controllers to manage the global strategies described in the System Software section.
 2. The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 3. Data shall be shared between networked Building Controllers.
 4. The operating system of the Building Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
 5. Controllers that perform scheduling shall have a real-time clock.
 6. The Building Controller shall communicate with other BACnet objects on the internetwork using the Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-2001.
 7. BACnet Functional Groups. The Building Controller shall support the following BACnet functional groups: Clock, Event Initiation, COV Event Response, Files, Device Communication and Time Master.
- B. Communication
1. Each Building Controller shall support BACnet™ over Ethernet and BACnet™ over IP. The Building Controller shall be connected to the BACnet network using the ISO 8802-3 (Ethernet) Data L/ Physical layer protocol.
 2. Each Building Controller with a communications card shall perform BACnet routing if connected to a network of Custom Application and Application Specific Controllers.
 3. The controller shall provide a service communication port using BACnet Data Link/ Physical layer protocol P-T-P for connection to a hand-held workstation/ and/or modem.
 4. The Building Controller secondary communication network shall support BACnet MS/TP.
- C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 0°C to 40°C [32°F to 100°F] and 10 to 90% RH.

2. Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 0°C to 50°C [32°F to 120°F].
- D. Building Controllers shall be fully peer to peer.
 - E. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field- removable, modular terminal strips — or to a termination card connected by a ribbon cable.
 - F. Memory. The Building Controller shall have as a minimum standard SRAM of 256 KB, standard DRAM of 1MB and standard non-volatile 1 MB of flash memory in lieu of EPROM. Memory shall be user extendible through RAM chip sockets and SIMMs for future memory expansion.
 - G. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. The Building Controller shall maintain all database information including BIOS and programming information in the event of a power loss for at least 72 hours. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m [3 ft].
 - H. Inputs/Outputs.
 1. Inputs. Controller input/output board shall support dry contact, 0-5 VDC and 0-10 VDC- voltage, 4-20 mA- current and thermistor-resistive signal types on an individual basis for connecting any status or sensing device. Analog resolution shall be 10-bit A to D.
 2. Outputs. Controller input/output board shall support built in HOA modules configured with manual-auto-off override switch. Output supported shall be 0-10 VDC. All HOA's shall be supervised.
 3. Diagnostics. Controller input/output board shall have red LEDs providing input status indication.
 4. Building Controller shall have the capability to create, delete and support the following BACnet Objects:
 - a. ANALOG INPUT, ANALOG OUTPUT AND ANALOG VALUE: These objects shall have the following writeable properties: Object Name; Object Value; Description; COV Increment; Out of Service and Units. In addition, these objects shall support the properties: Device type; Reliability; Min./Max. Values; Update Interval and Resolution.
 - b. BINARY INPUT, BINARY OUTPUT AND BINARY VALUE: These objects shall have the following writeable properties: Object Name; Object Value; Description; Polarity; Default Value; Min On/Off and Out of Service. In addition, these objects shall support the properties: Device Type; Reliability; Active/Inactive Texts; Update Interval; Resolution; Change-of-State Time; Count Times and Time Reset.
 - c. CALENDAR: This object shall have the following writeable properties: Object Name; Object Value; Description; and Date List.
 - d. DEVICE: This object shall have the following writeable properties: Object Name; Description; Location; and UTC Offset.

- e. EVENT ENROLMENT: This object shall have the following writeable properties: Object Name; Object Value; Description; Out-of-Service; Event & Notify Types; Parameters; Property Ref; Enable; and Notification Class.
- f. FILE: This object shall have the following writeable properties: Object Name; Description; File Type; and File Access.
- g. LOOP (PID): This object shall have the following writeable properties: Object Name; Object Value; Description; Polarity; Output and Input Refs.; Input Value & Units; Setpoint Value; PID Values; Bias; Write Priority and COV Increment. In addition, this object shall support the properties: Reliability; Update Interval; Proportional Constant & Units; Derivative Constant & Units.
- h. NOTIFICATION CLASS: This object shall have the following writeable properties: Object Name; Object Value; Description; Priority and Ack Required.
- i. PROGRAM: This object shall have the following writeable properties: Object Name; Object Value and Description. In addition, this object shall support the property Reliability.
- j. SCHEDULE: This object shall have the following writeable properties: Object Name; Object Value and Description; Effective period; Schedule; Exception; Controlled Properties and Write Properties.
- k. TREND LOG: This object shall have the following writeable properties: Object Name; Description; Log Enable; Start/stop Times; Log Device Object Property; Log Interval; Stop When Full; Buffer Size; and Record Count.

2.6 ADVANCED APPLICATION CONTROLLERS

- A. General. Provide an adequate number of Programmable Application Controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these panels shall meet the following requirements.
 - 1. The Advanced Application Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 - 2. Advanced Application Controllers shall be fully peer to peer.
 - 3. The operating system of the Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
 - 4. All equipment that requires scheduling shall be scheduled in that equipments controller.
 - 5. Both firmware and controller database shall be loadable over the network.
 - 6. Advanced Application Controllers shall support the following BACnet Interoperability Building Blocks (BIBBs):

Data Sharing	Alarm & Event	Scheduling	Trending	Device & Network Mgmt.
DS-RP-B	AE-N-B	SCHED-B		DM-DDB-B
DS-RPM-B	AE-ACK-B			DM-DOB-B
DS-WP-B	AE-ASUM-B			DM-DCC-B

DS-WPM-B				DM-TS-B
				DM-UTC-B
				DM-RD-B

- B. Communication.
 - 1. Each Advanced Application Controller shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol.
 - 2. The controller shall provide a service communication port using BACnet Data Link/ Physical layer protocol for connection to portable operators' workstation and allow access to the entire network.
- C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 0°C to 40°C [32°F to 100°F].
 - 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 0°C to 50°C [32°F to 120°F].
- D. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips — or to a termination card connected by a ribbon cable.
- E. Memory. The Advanced Application Controller shall be non-volatile FLASH memory.
- F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m [3 ft].

2.7 APPLICATION SPECIFIC CONTROLLERS

- A. General. Application Specific Controllers (ASCs) are microprocessor-based DDC controllers which through hardware or firmware design are able to control a wide variety of equipment. They are fully user-programmable, and are not restricted to any one type of equipment.
 - 1. Each ASC shall be capable of standalone operation and shall continue to provide control functions without being connected to the network
 - 2. Each ASC will contain sufficient I/O capacity to control the target system.
 - 3. Both firmware and controller database shall be loadable over the network
 - 4. Application Specific Controllers shall be fully peer to peer
 - 5. ASC's shall come with an integrated housing to allow for easy mounting and protection of the circuit board. Only wiring terminals shall be exposed.

6. Application Specific Controllers shall support the following BACnet Interoperability Building Blocks (BIBBs):

Data Sharing	Alarm & Event	Scheduling	Trending	Device & Network Mgmt.
DS-RP-B				DM-DDB-B
DS-WP-B				DM-DOB-B
				DM-DCC-B

- B. Communication
 - 1. The controller shall reside on a BACnet network using the MS/TP Data Link/ Physical layer protocol.
 - 2. Each controller shall have a BACnet Data Link/ Physical layer compatible connection for a laptop computer or a portable operator's tool. This connection shall be extended to a space temperature sensor port where shown and allow access to the entire network.
 - 3. Each controller shall have a secondary sub network for communicating sensors or I/O expansion modules
- C. Environment. The hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at -40°C to 65°C [-40°F to 150°F] and/or suitably installed in a heated or fan cooled enclosure
 - 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 0°C to 50°C [32°F to 120°F].
- D. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips.
- E. Memory. The Application Specific Controller shall use non-volatile memory and maintain all BIOS and programming information in the event of a power loss.
- F. Immunity to power and noise. ASC shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m [3 ft].
- G. Transformer. Power supply for the ASC must be rated at minimum of 125% of ASC power consumption, and shall be fused or current limiting type.
- H. Input/Output. ASC shall support as a minimum, directly connected, a combination of analog outputs and binary outputs and universal software selectable analog or digital inputs. ASC inputs shall support 0-5 VDC-voltage, 4-20mA-current, thermistor-resistance and dry contacts. ASC outputs shall support 0-10 VDC-voltage, digital triac rated at 0.5 amps at 24 VAC
- I. System Object Capacity. The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional

controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The Operator Workstations installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.10 AUXILIARY CONTROL DEVICES

- A. Motorized control dampers, unless otherwise specified elsewhere, shall be furnished by the controls contractor.
- B. Electric damper/valve actuators.
 - 1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
 - 2. Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing.
 - 3. All non-spring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 N·m [60 in·lb] torque capacity shall have a manual crank for this purpose.
- D. Control valves.
 - 1. Control valves shall be two-way or three-way type for two-position or modulating service as shown.
 - 2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a. Water Valves:
 - i. Two-way: 150% of total system (pump) head.
 - ii. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - b. Steam Valves: 150% of operating (inlet) pressure.
 - 3. Water Valves:
 - a. Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 - 4. Steam Valves:
 - a. Body and trim materials shall be per manufacturer's recommendations for design conditions and service. Linear ports for modulating service.
- E. Binary Temperature Devices
 - 1. Low-limit thermostats. Low-limit thermostats shall be vapor pressure type with an element 6 m [20 ft] minimum length. Element shall respond to the lowest temperature sensed by any 30 cm [1 ft] section. The low-limit thermostat shall be manual reset only and be supplied as DPST.
- F. Temperature sensors.
 - 1. Temperature sensors shall be thermistors.
 - 2. Space sensors shall be equipped with the following:
 - a. programmable buttons for setpoint adjustment and override
 - b. 3-value, 96-segment LCD display

- c. Communication port connected to entire network
- 3. Provide matched temperature sensors for differential temperature measurement.
- G. Humidity Sensors:
 - 1. Duct and room sensors shall have a sensing range of 20% to 80%.
 - 2. Duct sensors shall be provided with a sampling chamber.
 - 3. Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH. They shall be suitable for ambient conditions of -40°C to 75°C [-40°F to 170°F].
 - 4. Humidity sensor's drift shall not exceed 3% of full scale per year.
- H. Flow switches.
 - 1. Flow-proving switches shall be either paddle or differential pressure type, as shown.
- I. Pressure transducers
 - 1. Transducer shall have linear output signal. Zero and span shall be field-adjustable.
 - 2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage
 - 3. Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 1 - 5vdc or 4 to 20 mA output, required mounting brackets, and block and bleed valves.
 - 4. Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 1 – 5vdc or 4 to 20 mA output, required mounting brackets, and five-valve manifold.
- R. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application, or as shown.
- S. Pressure-Electric (PE) Switches
 - 1. Shall be metal or neoprene diaphragm actuated, operating pressure rated 0–175 kPa [0–25 psig], with calibrated scale setpoint range of 14–125 kPa [2–18 psig] minimum, UL listed
 - 2. Provide one- or two-stage switch action SPDT, DPST, or DPDT, as required by application.
 - 3. Shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified
 - 4. Shall have a permanent indicating gauge on each pneumatic signal line to PE switches.
- T. Electro-pneumatic (E/P) transducers
 - 1. Electronic/pneumatic transducer shall provide a proportional 20 to 100 kPa [3 to 15 psig] output signal from a 0 to 10 VDC analog control input.

- U. Local control panels
 - 1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with [hinged door], key-lock latch, removable sub-panels. A single key shall be common to all field panels and sub-panels
 - 2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings
 - 3. Provide 120v receptacle at each local panel location.

2.11 WIRING AND RACEWAYS

- A. General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 16.
- B. All insulated wire to be copper conductors, UL labeled for 90C minimum service

PART 3: EXECUTION

3.1 EXAMINATION

- A. Part Includes:
 - 1. Examination
 - 2. Protection
 - 3. Coordination
 - 4. General Workmanship
 - 5. Field Quality Control
 - 6. Existing Equipment
 - 7. Wiring
 - 8. Communication Wiring
 - 9. Fiber Optic Cable
 - 10. Control Air Tubing
 - 11. Installation of Sensors
 - 12. Flow Switch Installation
 - 13. Actuators
 - 14. Warning Labels
 - 15. Identification of Hardware and Wiring
 - 16. Controllers
 - 17. Programming
 - 18. Control System Checkout and Testing
 - 19. Control System Demonstration and Acceptance
 - 20. Cleaning
 - 21. Training
 - 22. Sequences of Operation
- B. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started

- C. The Contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started
- D. The Contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate — or if any discrepancies occur between the plans and the Contractor's work, and the plans and the work of others — the Contractor shall report these discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate the Contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the Contractor to report such discrepancies shall be made by — and at the expense of — this Contractor.

3.2 PROTECTION

- A. The Contractor shall protect all work and material from damage by its work or employees, and shall be liable for all damage thus caused
- B. The Contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted. The Contractor shall protect any material that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects

3.3 COORDINATION

- A. Site
 - 1. Where the mechanical work will be installed in close proximity to, or will interfere with work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. If the Contractor installs its work before coordinating with other trades, so as to cause any interference with work of other trades, the Contractor shall make the necessary changes in its work to correct the condition without extra charge
 - 2. Coordinate and schedule work with all other work in the same area, or with work which is dependent upon other work, to facilitate mutual progress.
- B. Submittals. Refer to the "Submittals" Article in Part 1 of this specification for requirements
- C. Test and Balance
 - 1. The Contractor shall furnish all tools necessary to interface to the control system for test and balance purposes
 - 2. The Contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours
 - 3. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
 - 4. The tools used during the test and balance process will be returned at the completion of the testing and balancing

- D. Life Safety
 - 1. Duct smoke detectors required for air handler shutdown are supplied and installed under Division 16. The Division 16 Contractor shall interlock smoke detectors to air handlers for shutdown as described in Part 3: "Sequences of Operation".
 - 2. Smoke dampers and actuators required for duct smoke isolation are provided under another Division 15 Section
 - 3. Fire/smoke dampers and actuators required for fire rated walls are provided under another Division 15 Section. Control of these dampers shall be by Division 16.
- E. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the Contractor as follows:
 - 1. All communication media and equipment shall be provided as specified in Part 2: "Communication" of this specification.
 - 2. Each supplier of controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
 - 3. The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other sections or divisions of this specification.

3.4 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment
- C. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
- D. All wiring shall be verified for its integrity to ensure continuity and freedom from shorts and grounds
- E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship
- C. Contractor shall have work inspected by local and/or state/provincial authorities having jurisdiction over the work

3.6 EXISTING EQUIPMENT

- A. Wiring: The contractor may reuse any abandoned wires. The integrity of the wire and its proper application to the installation is the responsibility of the Contractor. The wire shall be properly identified and tested as per this specification. Unused or redundant wiring must be properly identified as such.
- B. Pneumatic Tubing: The Contractor may reuse any redundant pneumatic tubing. The integrity of the tubing and its proper application to the installation is the responsibility of the Contractor. The tubing shall be properly identified and tested as per this specification. Unused or redundant tubing must be removed, or where this is not possible, properly identified
- C. Local Control Panels: The Contractor may reuse any existing local control panel to locate new equipment. All redundant equipment within these panels must be removed. Panel face cover must be patched to fill all holes caused by removal of unused equipment, or replaced with new.}.
- D. Unless otherwise directed, the Contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the Contractor find existing equipment which requires maintenance, the Engineer is to be notified immediately
- E. Temperature Sensor Wells: The Contractor may reuse any existing wells in piping for temperature sensors. These wells shall be modified as required for proper fit of new sensors
- F. Indicator Gauges: Where these devices remain and are not removed, they must be made operational and recalibrated to ensure reasonable accuracy. Maintain the operation of existing pneumatic transmitters and gauges.
- G. Room Thermostats: {Deliver to Owner}
- H. Electronic Sensors and Transmitters: Unless specifically noted otherwise, {remove and deliver to the Owner}.
- I. Controllers and Auxiliary Electronic Devices: {Deliver to the Owner}.
- J. Pneumatic Controllers, Relays and Gauges: {Deliver to Owner}.
- K. Damper Actuators, Linkages and Appurtenances: {Deliver to Owner} {Salvage, recondition, and reuse} {Become the property of the Contractor}
- L. Control Valves: {Replace with new}.
- M. Control Compressed Air System: {Deliver to Owner and replace with new system}.
- N. The mechanical system must remain in operation between the hours of 6 a.m. and 6 p.m., Monday through Friday. No modifications to the system shall cause the mechanical system to be shut down for more than 15 minutes or to fail to maintain space comfort condition during any such period. Perform cutover of controls that cannot meet these conditions outside of those hours

- O. The scheduling of fans through existing or temporary time-clocks or control system shall be maintained throughout the DDC system installation.
- P. Install control panels where shown
- Q. Modify existing starter control circuits, if necessary, to provide Hand/Off/Auto control of each starter controlled.
- R. Patch holes and finish to match existing

3.7 WIRING

- A. All control and interlock wiring shall comply with national and local electrical codes and Division 16 of this specification. Where the requirements of this section differ with those in Division 16, the requirements of this section shall take precedence.
- B. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway per NEC and Division 16 requirement.
- C. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)

3.12 ACTUATORS

- A. Mount and link control damper actuators per manufacturer's instructions.
 - 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/Electronic
 - 1. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations
 - 2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.14 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels, shall be labelled at each end within 5 cm [2"] of termination with the DDC address or termination number.
- B. Permanently label or code each point/object of field terminal strips to show the instrument or item served.
- C. Identify control panels with minimum 1 cm [½"] letters on laminated plastic nameplates.

- D. Identify all other control components with permanent labels. All plug-in components shall be labelled such that removal of the component does not remove the label.
- E. Identify room sensors relating to terminal box or valves with nameplates.

3.15 CONTROLLERS

- A. Provide a separate controller for each AHU or other HVAC system.
- B. Building Controllers and Advanced Application Controllers shall be selected to provide a minimum of 15% spare I/O point/object capacity for each point/object type found at each location. If input /objects are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point/object used.
 - 1. Future use of spare capacity shall require providing the field device, field wiring, point/object database definition, and custom software. No additional controller boards or point/object modules shall be required to implement use of these spare points

3.16 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free for future use.
- B. Point/object Naming: System point/object names shall be modular in design, allowing easy operator interface without the use of a written point/object index. Use the following naming convention:
AAABBBCCDDDEEE where:
AAA is used to designate the location of the point/object within the building such as mechanical room, wing, or level, or the building itself in a multi-building environment.
BBB is used to designate the mechanical system with which the point/object is associated (e.g., A01, HTG, CLG, LTG).
CCC represents the equipment or material referenced (e.g., SAF for supply air fan , EXF for exhaust fan, RAF for return air fan).
D or *DD* or *DDD* may be used for clarification or for identification if more than one of CCC exists (e.g., SAF10, EXF121).
EE represents the action or state of the equipment or medium (e.g., T for temperature, RH for humidity, CO for control, S for status, D for damper control, I for current).

- C. Software Programming
 - 1. Provide programming for the system and adhere to the sequences of operation provided. The Contractor also shall provide all other system programming necessary for the operation of the system, but not specified in this document. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - a. Text-based:
 - i. must provide actions for all possible situations
 - ii. must be modular and structured
 - iii. must be commented
 - b. Graphic-based
 - i. must provide actions for all possible situations
 - ii. must be documented
 - c. Parameter-based
 - i. must provide actions for all possible situations
 - ii. must be documented
- D. Operator Interface
 - 1 Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point/object information on the graphic displays shall dynamically update. Show on each graphic all input and output points/objects for the system. Also show relevant calculated points/objects such as setpoints
 - 2 Show terminal equipment information on a "graphic" summary table. Provide dynamic information for each point/object show
 - 3 The Contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all Operator Workstation software and their functions as described in this section. This includes any operating system software, the Operator Workstation database, and any third-party software installation and integration required for successful operation of the operator interface

3.17 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Start-up Testing: All testing listed in this article shall be performed by the Contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner's Representative is notified of the system demonstration.
 - 1. The Contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification
 - 2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight
 - 3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers' recommendations

4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct
5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The Contractor shall check all control valves and automatic dampers to ensure proper action and closure. The Contractor shall make any necessary adjustments to valve stem and damper blade travel
6. Verify that the system operation adheres to the Sequences of Operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum Start/Stop routines.
7. Alarms and Interlocks
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action

3.18 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed its own tests
2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, startup, and debugging process and as specified in the "Control System Checkout and Testing" Article in Part 3 of this specification. The Engineer will be present to observe and review these tests. The Engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1: "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration
4. The Contractor shall provide at least two persons equipped with two-way communication, and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point/object and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

6. Demonstrate compliance with Part 1: "System Performance
 7. Demonstrate compliance with Sequences of Operation through all modes of operation
 8. Demonstrate complete operation of Operator Workstation
 9. Additionally, the following items shall be demonstrated:
 - a) DDC Loop Response. The Contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in setpoint, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the setpoint, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - b) Demand limiting. The Contractor shall supply a trend data output showing the action of the demand-limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting setpoint, and the status of shed-able equipment outputs.
 - c) Optimum Start/Stop. The Contractor shall supply a trend data output showing the capability of the algorithm. The hour-by-hour trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas
 - d) Interface to the building fire alarm system
 - e) Operational logs for each system that indicate all setpoints, operating points, valve positions, mode, and equipment status shall be submitted to the Architect/Engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
 - f) Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.
- B. Acceptance
1. All tests described in this specification shall have been performed to the satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting the requirements of Completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.
 2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1: "Submittals."

3.19 CLEANING

1. The Contractor shall clean up all debris resulting from its activities daily. The Contractor shall remove all cartons, containers, crates, etc., under its control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
2. At the completion of work in any area, the Contractor shall clean all of its work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
3. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.20 TRAINING

- A. General
 1. Provide a minimum of one onsite training class 8 hours in length during the construction period for personnel designated by the owner.
 2. Provide two additional training sessions at 6 and 12 months following building's turnover. Each session shall be 8 hrs in length and must be coordinated with the building Owner.
- B. Train the designated staff of Owner's Representative and Owner to enable Day-to-day Operators to:
 1. Proficiently operate the system.
 2. Understand control system architecture and configuration.
 3. Understand DDC system components.
 4. Understand system operation, including DDC system control and optimizing routines (algorithms).
 5. Operate the workstation and peripherals.
 6. Log on and off the system.
 7. Access graphics, point/object reports, and logs.
 8. Adjust and change system setpoints, time schedules, and holiday schedules.
 9. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
 10. Understand system drawings, and Operation and Maintenance manual.
 11. Understand the job layout and location of control components.
 12. Access data from DDC controllers and ASC.
 13. Operate portable operator's terminals.
- C. Train the designated staff of Owner's Representative and Owner to enable Advanced Operators to:
 1. Make and change graphics on the workstation
 2. Create, delete, and modify alarms, including annunciation and routing of these
 3. Create, delete, and modify point/object trend logs, and graph or print these
 4. Create, delete, and modify reports
 5. Add, remove, and modify system's physical points/objects
 6. Create, modify, and delete programming

7. Add panels when required
 8. Add Operator Workstation stations
 9. Create, delete, and modify system displays — both graphical and otherwise
 10. Perform DDC system field checkout procedures
 11. Perform DDC controller unit operation and maintenance procedures
 12. Perform workstation and peripheral operation and maintenance procedures
 13. Perform DDC system diagnostic procedures
 14. Configure hardware including PC boards, switches, communication, and I/O points/objects
 15. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
 16. Adjust, calibrate, and replace system components
- D. Train the designated staff of Owner's Representative and Owner to enable System Managers/Administrators to:
1. Maintain software and prepare backups
 2. Interface with job-specific, third-party operator software
 3. Add new users and understand password security procedures
- E. Provide course outline and materials as per "Submittals" Article in Part 1 of this specification. The instructor(s) shall provide one copy of training material per student.
- F. The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- G. Classroom training shall be done using a network of working controllers representative of the installed hardware.

END OF SECTION

- SECTION 312300 - EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Earthwork operations:
 - 1. Erosion and sediment control.
 - 2. Excavating for footings and foundations.
 - 3. Requirements for trenching, ~~and bedding,~~ and filling of pipeline trenches performed under separate respective utility sections.
 - 4. Furnishing and installing granular base course, as required, under vapor retarders at interior concrete slabs on grade, behind retaining walls, and for trench bedding.
- B. Referenced Sections:
 - 1. Section 013300 - Submittal Procedures.
 - 2. Section 014500 - Quality Control: Administrative requirements for laboratory testing.
 - 3. Section 015200 - Construction Facilities.
 - 4. Section 017123 - Field Engineering: General requirements for engineering services during construction.
 - 5. Section 017419 - Construction Waste Management and Disposal.
 - 6. Section 033000 - Cast-in-Place Concrete: Requirements for vapor retarder.
 - 7. ~~Section 334613 - Foundation Drainage.~~

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. C 33-13 - Specification for Concrete Aggregates.
 - 2. D 422-63(2007) Standard Test Method for Particle-Size Analysis of Soils .
 - 3. D 1556-08a - Test Method for Density of Soil in Place by Sand-Cone Method.
 - 4. D 2419-09 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
 - 5. D 2487-11 - Classification of Soils for Engineering Purposes.
 - 6. D 2488-09a - Practice for Description and Identification of Soils (Visual-Manual Procedure).
 - 7. D 4318-10 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - 8. D 6938-10 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

- B. California Code of Regulations (CCR):
 - 1. Title 24, Part 2- California Building Code (CBC), 2013 edition:
 - a. Chapter 11B - Accessibility to Public Buildings, Public Accommodations, Commercial Buildings, and Public Housing:
 - 1) Division 4 - Accessible Routes.
 - a) Section 403 - Walking Surfaces.
 - b. Chapter 18A - Foundations and Retaining Walls.
 - c. Chapter 33 - Safeguards During Construction.
 - 2. California Green Building Standards Code (CALGreen Code) [CCR Title 24, Part 11] (CGC), 2013 edition.
- C. California Occupational Safety and Health Standards (OSHA):
 - 1. Article 6 - Excavations and Shoring.
- D. California Department of Transportation (CALTRANS):
 - 1. Standard Specifications, latest edition.
- E. Public Works Standards, Inc. (PWS):
 - 1. *Standard Specifications* for Public Works Construction, (Greenbook), latest edition with amendments, published by BNi Building News, division of BNi Publications, Inc., Anaheim, CA (714)517-0970.

1.03 DEFINITIONS

- A. *Excavation* consists of removal and disposal of *material* encountered when establishing required grade elevations.
- B. *Material* includes soils, obstructions visible on ground surface, underground structures, and utilities indicated to be removed, and other items encountered that are not classified as rock excavation or *unauthorized excavation*.
- C. *Over-Excavation*: Consists of removal of unsuitable soil materials to approved suitable subgrade, as shown on the Contract Drawings.
- D. *Unauthorized Excavation* consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Architect.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Refer to Section 017419 regarding procedures for implementing construction waste management requirements.
- B. Layout and Grades: Contractor shall provide construction surveying by a registered land surveyor or professional civil engineer licensed to practice in the State of California for the following:
 - 1. Providing line and grade for footings and foundations.
 - 2. Providing line and grade survey for water, storm and sanitary sewer pipes and location of structures.
 - 3. Provision and maintenance of all surveying stakes, lines, and benchmarks.

1.05 SUBMITTALS

- A. Quality Control Submittals:
 - 1. Test Reports: In accordance with the provisions of Section 013300, and in conjunction with the requirements of Section 014500, submit the following:
 - a. Verification of excavations and footing subgrades.

1.06 QUALITY ASSURANCE

- A. Certification:
 - 1. Certify levels of excavations, footings, and subbed grades by licensed surveyor.

1.07 FIELD CONDITIONS

- A. Underground Utilities: *Buried utility lines may exist.* If encountered, notify the Architect for direction on preservation, relocation, or demolition.
 - 1. Cooperate with Owner and utility companies in maintaining respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
 - 2. Do not interrupt existing utilities serving facilities occupied by Owner or others, except when authorized in writing by Owner, and then only after acceptable temporary utility services have been provided.
 - 3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Regulations: Comply with applicable portions of codes and regulations of governmental agencies having jurisdiction, including applicable portions of CBC Chapter 33 and Appendix J. Where those requirements conflict with the Contract Drawings, comply with the more stringent provisions.
 - 1. *Work not covered by governing agency standards shall conform to Contract Drawings and Project Manual, in that order.*
 - 2. Comply with appropriate provisions of the Storm Water Pollution Prevention Plan regarding cleaning and protection.

2.02 PERFORMANCE CRITERIA

- A. Performance Requirements: Classification of soils when made in connection with the work of this Contract shall be in accordance with the applicable requirements of ASTM D 2487 and ASTM D 2488.

2.03 MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

- B. Subslab Base (Aggregate): Provide clean, free-draining aggregate, having a gradation equal to the following:

SIEVE SIZE	PERCENTAGE PASSING
1-inch	100
3/8	30-100
No. 4	0-5

- C. Utility Trench Pipe Bedding: Clean, free-draining sand, gravel, crushed aggregate, or native materials having a Sand Equivalent of not less than 30, as determined in accordance with ASTM D 2419.
- D. Porous Fill: Crushed stone or gravel complying with ASTM C 33, Size No. 57.
- E. Permeable Material: Caltrans Class 2 permeable material per section 68-1.025 of the latest Caltrans Standard Specifications.
- F. Water: Clean and free from deleterious amounts of acids, alkalis, salts, and organic matter.
- G. Geotextile Tensile Fabric: Mirafi 600X, or equal.
- H. Filter Fabric: Mirafi 140N, or equal.
- I. Vapor Retarder: Refer to Section 033000.
- J. Shoring Materials: Provide materials for shoring and bracing in good and serviceable condition.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Prior to and during the work of this Section, examine site conditions and previously performed work, and verify that soil conditions are suitable.

3.02 PREPARATION

- A. Protection:
 1. Provide and maintain planking and protection for walks, curbs, and drains. Prevent damage by trucking, grading, and other operations.
 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
 3. Barricade open excavations occurring as part of this work with a minimum 5-foot setback and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
 4. Keep adjacent streets and drives clean of any dirt created by earthwork operations.
- B. Erosion and Sediment Control: Comply with requirements and recommendations of Contract Civil Drawings.

- C. Dust Control:
 - 1. Control dust on and near the work, and on and near off-site borrow areas.
 - 2. Moisten surfaces as required to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other activities on the site.
 - 3. Install synthetic soil binder in accordance with manufacturer's instructions as required to control dust.
- D. Ground Surface Preparation:
 - 1. Coordinate clearing and stripping with work of Section ~~024113~~024119. ~~Conform to the general requirements of Section 311000.~~
 - a. Stockpile reusable soils in a location acceptable to the Owner.
 - b. Remove rejected soils from the site for disposal in a legal manner.
 - 2. Proof Rolling: Proof roll stripped surfaces to ascertain the presence of soft, wet, yielding soils or other unstable materials that must be undercut.
- ~~E. Subdrains: In accordance with Section 334613, provide subdrains for retaining walls and as shown on the Contract Drawings.~~

3.03 EXCAVATION

- A. Shoring and Bracing:
 - 1. Stability of Excavations: Maintain sides and slopes of excavations in a safe condition until completion of backfilling.
 - 2. Provide minimum requirements for trench shoring and bracing to comply with applicable codes and regulations.
 - a. Shore in accordance with OSHA Article 6 requirements for construction safety.
 - 3. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
- B. Dewatering: Provide and maintain, at all times during construction, the means and devices with which to promptly remove and properly dispose of water entering structural excavation, pipe trenches, and other excavations. Accomplish dewatering by methods that will ensure a dry excavation and the preservation of required lines and grades. Dewatering methods employed shall comply with local water quality control regulations.
 - 1. Commence dewatering for structures and pipelines when water is first encountered and continue until excavation is dry enough to continue operations.
 - a. No concrete shall be laid in water, nor shall water be allowed to rise over them until the concrete has set for at least 8 hours.
 - 2. Do not allow water to rise around pipes until joint compounds have set hard and there is no possibility of flotation.
 - 3. Dispose of water from the work in a suitable manner without damage to adjacent property. Do not drain water into work already built or under construction.

4. Dispose of water in a manner that will not constitute a nuisance or a menace to public health and safety.
- C. Pipeline Trench Excavation:
1. Provide open-cut trenches for pipelines. Excavate bottom of trenches uniformly to the same grade of the bottom of the pipe.
 2. Over-Excavation, When Ordered: Over-excavate trenches, beyond the depth indicated on the Contract Drawings. Refill trench to the grade of the bottom of the pipe with material specified for pipe bedding.
 - a. Place bedding material in layers, condition to optimum moisture content, and compact as specified below.
 - b. Perform over-excavation less than 6 inches below the limits indicated at no additional cost to the Owner. Additional payment will be made to the Contractor in accordance with a negotiated price when the over-excavation is 6 inches or greater below the limits shown.
 3. Over-Excavation, When Not Ordered, Specified, or Shown: Refill to the required grade as specified above when over-excavation is carried below the grade specified. No additional payment will be made to Contractor for such overexcavation.
 4. Refer to Divisions 21 to 26 for additional requirements related to underground mechanical and electrical installations.
 5. Refer to Division 33 for additional requirements related to underground utility installations.
- D. Excavation for Structures:
1. Excavate materials within the proposed building area to satisfactory soil conditions.
 2. Conform to elevations and dimensions shown within a tolerance of plus-or-minus 0.10-foot, and extend a sufficient distance from footings and foundations to permit placement and removal of concrete formwork, installation of services, and inspection.
- E. Material Storage: Stockpile satisfactory excavated materials where directed by Owner until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
1. Locate and retain soil materials away from edge of excavations.
 2. Dispose of excess soil material and waste materials in a legal manner.
- F. Use of Explosives:
1. Use of explosives is not permitted.

3.04 FILL

- A. Trenches: Conform to Section 306-1.3 of the *Standard Specifications* regarding backfill of trenches.
1. Prepare trench with bed of 3/4-inch aggregate 4 inches to 6 inches deep and thoroughly densify. Give trench bottom a final trim using a string line, such that each pipe section when first laid will be continually in contact with the gravel layer along the extreme bottom of the pipe. Cover the pipe with aggregate fill as indicated on the Contract Drawings and compact to 90 percent relative compaction.

2. Backfill with utility trench pipe bedding to 12 inches over pipe. Fill balance of trench with on-site soils, or as indicated on Contract Drawings.
- B. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Acceptance by Architect of construction below finish grade including, where applicable, waterproofing and drainage systems.
 2. Inspection, testing, and approval of underground utilities by governing agencies, including survey of underground utilities.
 3. Removal of concrete formwork.
 4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
 5. Removal of trash and debris.
 6. Completion of permanent or temporary horizontal bracing on horizontally supported walls and retaining walls.
- C. Backfilling Unauthorized Excavation:
1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending the indicated bottom elevation of the footing or base to the excavation bottom, without altering required top elevation.
 - a. Lean concrete fill may be used to bring elevations to proper position only when acceptable to Architect.
- D. Place fill material in layers to required subgrade elevations for each area classification listed below:
1. Under grassed areas, use excavated or borrow material acceptable to Architect.
 2. Under concrete pedestrian and vehicular pavements, provide subslab base material.

3.05 COMPACTION

- A. General: Control soil compaction during construction to provide required minimum percentage of maximum density specified for each area classification. Comply with requirements of ASTM D 1556. Comply with requirements of ASTM D 1557, Method D, corrected by replacement for material retained on the 3/4-inch sieve. When the amount of material retained on the 3/4-inch sieve is less than 10 percent, use Method C.
1. Compaction and testing for paved areas shall be performed immediately prior to installation of paving. Subgrades subjected to wet weather prior to paving shall be retested at Contractor's expense. Subgrade not in conformance with these Specifications at time of paving shall be recompacted.
- B. Moisture Control: Where subgrade, or layer of soil material, requires moisture conditioning before compaction, uniformly apply water to surface of subgrade, or layer of soil material, preventing free water from appearing on surface during, or subsequent to, compaction operations.
1. The moisture content of the fill soils at the time of compaction shall not vary more than 3 percent above optimum moisture content.

2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
 3. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing, or pulverizing, until moisture content is reduced to a satisfactory value, as determined by moisture-density tests.
- C. Maximum Density Requirements: Percentages of maximum density of soil material, compacted at near optimum moisture content, shall be 90% unless otherwise indicated on Contract Drawings.

3.06 FINISH GRADING

- A. General: Uniformly grade areas to specified tolerances between points where elevations are shown, or between points and existing grades.
- B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures without ponding. Finish surfaces free from irregularities and abrupt changes, and as follows:
 1. Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 0.05-foot above or below the required subgrade elevation.
 2. Walks: Shape surface of areas under walks to line, grade, and cross-section, with finish surface not more than 0.04-foot above or below the required subgrade elevation.
 3. ~~Grassed Areas: Finish areas to within not more than 0.10-foot above or below the required finish grade elevations. Slope drainage away from building. Refer to Section 329119.~~
- C. Grading for Accessibility: Surface slopes for accessible parking spaces and access aisles shall not exceed 2 percent in any direction, in accordance with CBC 11B-403.3.

3.07 SUBSLAB BASE

- A. Install aggregate base over subgrade as indicated on the Contract Drawings.
- B. Install vapor retarder over subgrade or over aggregate base at all on-grade slabs to be finished with floor coverings, and as indicated on the Contract Drawings.
 1. Refer to Section 033000 for vapor retarder installation requirements.
- C. Do not install subslab base material over vapor retarder at on-grade slabs.

3.08 FIELD QUALITY CONTROL

- A. Foundation: Test of subgrades and fill layers shall be performed as follows:
 1. Footing Subgrade: For each compacted layer on which footings will be placed, conduct at least one field density test for every 2000 square feet of subgrade to verify required soils density.
 2. Paved Areas Subgrade: Conduct at least one field density test of subgrade for every 2000 square feet of paved areas or building slab,

but in no case less than three tests. In each compacted fill layer, make one field density test for every 2000 square feet of overlaying building slab or paved area, but in no case less than three tests.

3. Moisture Barrier: Inspect moisture barrier for proper lapping installation, without breaks or punctures, prior to installation of subslab base.
4. Trenches: Conduct one field density test at vertical intervals not exceeding 2 feet, and at horizontal intervals not exceeding 200 feet of trench.

3.09 ADJUSTING

- A. Reconditioning: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density and moisture content prior to further construction.

3.10 CLEANING

- A. Remove and legally dispose of trash, debris, and waste materials from the site.
 1. Dispose of surplus excavated materials off site.

3.11 PROTECTION

- A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion, and keep free of trash and debris.
 1. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- B. Erosion Control: At the completion of grading operations provide protection from erosion due to wind and water at those areas where construction is not immediately anticipated.
 1. Coordinate operations with landscaping work to provide planting or hydroseeding of native grasses as a temporary or permanent solution to minimize erosion damage.
 2. Remove erosion control devices and return surfaces to natural conditions.

END OF SECTION

- SECTION 331000 - WATER UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Requirements for installation [and disinfection](#) of water systems.
- B. Related Sections of Work:
 - 1. Section 013300 - Submittal Procedures.
 - 2. Section 312300 - Earthwork.
 - 3. Section 334000 - Storm Drainage Utilities.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. B 75-10 Standard Specification for Seamless Copper Tube.
 - 2. B 88-09 - Specification for Seamless Copper Water Tube
 - 3. D 1785-06 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 - 4. D 2241-09 - Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
 - 5. D 2466-06 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - 6. D 2855-96(2010) - Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
- B. California Department of Transportation (CALTRANS):
 - 1. Standard Specifications.
 - 2. California Test No. 217.
 - 3. California Test No. 229.
- C. American Society of Mechanical Engineers (ASME):
 - 1. B16.18-2001 - Cast Copper Alloy Solder Joint Pressure Fittings.
 - 2. B16.22-2001 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. American National Standards Institute (ANSI):
 - 1. A21.1 - Thickness Design of Cast Iron-Pipe
 - 2. A21.4 - Cement-Mortar Lining for Cast-Iron and Ductile-Iron Pipe and Fittings for Water.
 - 3. A21.10 - Gray-Iron and Ductile-Iron Fittings, 3 Inches Through 48 Inches for Water and Other Liquids.
 - 4. A21.11 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.

5. A21.50 - Thickness Design of Ductile-Iron Pipe.
 6. A21.51 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- E. American Water Works Association (AWWA):
1. C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 2. C111 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
 3. C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
 4. C500 - Gate Valves, 3 Inches Through 48 Inches NPS, for Water and Sewage Systems.
 5. C502 - Wet Barrel Fire Hydrants.
 6. C504 - Rubber-Sealed Butterfly Valves.
 7. C508 - Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS.
 8. C600 - Installation of Ductile-Iron Water Mains and Appurtenances.
 9. C651 - Disinfecting Water Mains.
 10. C800 - Underground Service Line Valves and fittings.
 11. C900 - Polyvinyl Chloride (PVC) Pressure Pipe 4 Inches Through 12 Inches for Water.
- F. Public Works Standards, Inc. (PWS):
1. *Standard Specifications* for Public Works Construction, (Greenbook), 2012 edition with amendments, published by BNi Building News, division of BNi Publications, Inc., Anaheim, CA (714)517-0970.
- G. National Fire Protection Association (NFPA):
1. 13 - Installation of Sprinkler Systems, 2010 edition.
 2. 24 - Installation of Private Fire Service Mains and Their Appurtenances, 2010 edition.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meetings: Conduct pre-construction conference to review requirements with all entities involved, including water engineering staff of regulatory agency.
- B. Secure required permits.

1.04 SUBMITTALS

- A. Product Data and Shop Drawings: In accordance with provisions of Section 013300, submit product data and Shop Drawings that relate to fire service elements of Project.
- B. Certificates:
 1. Furnish copies of NFPA certificate to Owner, Architect, DSA, and local fire official.
- C. Test Data and Evaluation Reports:
 1. Disinfection Report:
 - a. Type and form of disinfectant used.

- b. Date and time of disinfectant injection start and time of completion.
 - c. Test locations.
 - d. Name of person collecting samples.
 - e. Initial and 24-hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - f. date and time of flusing start and completion.
 - g. Disinfectant residual after flushing in ppm for each outlet tested.
2. Bacteriological Report:
- a. Date issued, project name, and testing laboratory name, address, and telephone number.
 - b. Time and date of water sample collection.
 - c. Name of person collecting samples.
 - d. Test locations.
 - e. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
 - f. Coliform bacteria test results for each outlet tested.
 - g. Certification that water conforms, or fails to conform, to bacterial standards of local municipality.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. General: Water pipe, fittings, hydrants, and valves shall be carefully handled at all times. Only suitable and proper equipment and appliances shall be used for the safe loading, hauling, unloading, handling, and placing of materials.
- B. Soil at Project site is highly corrosive; special care shall be exercised so that the coating on pipe, valves, and fittings is not damaged. If such damage should occur, the coating shall be repaired to the satisfaction of the Architect. Chain slings shall not be permitted. Pipe loaded on trucks or stacked one upon another shall be supported on wooden blocking. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. **Regulations:** Comply with PWS *Standard Specifications* Section 205 for water distribution systems, water engineering division of public utilities having jurisdiction, and applicable AWWA standards and specifications. Where those requirements conflict with the Contract Drawings, comply with the more stringent provisions.
 1. *Work not covered by governing agency standards shall conform to Contract Drawings and Project Manual, in that order.*

2.02 PERFORMANCE CRITERIA

- A. Mains: Refer to Article 2.03.
- B. Fire Sprinkler Service Lines:
 1. Work shall comply with the requirements of NFPA 13 and NFPA 24 including appendices, as required.

2. The general extent of the work of this Section as noted on the Contract Drawings and includes, but is not necessarily limited to, the following:
 - a. Construction of underground fire sprinkler service lines to the connection at sprinkler riser in building.
 - b. Construction of fire protection water system components including fittings and thrust blocks as required.
 - c. Testing for pressure and leakage.
 - d. Flushing of the completed installation.
 - e. Obtaining of permits.
3. If not otherwise indicated on Contract Drawings, the PVC portion of fire sprinkler service lines shall stop 5 feet from the building foundation.

2.03 MATERIALS

- A. Pipe:
 1. Ductile Iron:
 - a. AWWA C151 Class 51, cement-lined in accordance with ANSI A21.4.
 - b. Pipe ends shall be bell and spigot with mechanical joints that conform with ANSI A21.11 or with ends joined by a method that employs a single circular rubber gasket, subject to approval by the Architect.
 - c. Provide heavy duty corrosion and cathodic protection for all ferrous metal materials used underground.
 2. Polyvinyl Chloride (PVC): AWWA C900, Class 200 minimum.
 - a. Provide Class 200 pipe where pressure exceeds 150 psi.
 - 1) Fire water supply piping shall be Class 200.
 3. Copper:
 - a. ASTM B 88, Type K, annealed.
 4. Polyethylene:
 - a. AWWA C901, molded or fabricated.
- B. Water Service Lines:
 1. 2-1/2-inch Lines and Smaller: Provide water service lines from water meter to building service at a point approximately 5 feet from building. Water service lines shall be Type K copper tubing or acrylonitrile-butadiene-styrene (ABS) plastic pipe, Schedule 80.
 - a. Solder: 95-5 tin antimony hard solder or J.W. Harris Sta-Safe lead-free solder.
 2. 3-inch Lines and Larger: AWWA C900, Class 200 PVC pipe, Class 200 cast iron, or ductile iron with mechanical joints.
- C. Mains:
 1. Type: Ductile iron, or polyvinyl chloride (PVC).
 2. Pipe Size: As indicated on Contract Drawings.
 3. Location: As indicated on Contract Drawings.
 4. Depth: The minimum cover shall be 3.5 feet.
- D. Reclaimed Water: PVC pipe to be color coded *purple* in color and downstream of the backflow prevention unit shall be solvent weld PVC marked on two sides with Reclaimed water warning statements **CAUTION - RECLAIMED WATER**. Reclaimed water piping must be

accepted by the local reclaimed water governing agencies. Reclaimed water PVC pipe shall use standard Schedule. 40 PVC fittings.

- E. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with **WATER SERVICE** in large letters.

2.04 PIPE FITTINGS

- A. Fittings and Joints:
1. Ductile Iron:
 - a. Fittings, Twelve-inch and Smaller: Cement-lined in accordance with ANSI/AWWA C104/A21.4.
 - 1) Mechanical joint, spigot, or modified bell ends may be substituted for the bell ends. Flange ends may be substituted only with the Architect's approval.
 - b. Joints: ANSI/AWWA C111/A21.11, rubber gasket with rods.
 2. Polyvinyl Chloride (PVC):
 - a. Fittings: ANSI A21.10 gray-iron or ductile iron for use with PVC pipe and with mechanical joint ends.
 - b. Couplings: Certainteed Corporation Fluid-Tite, Johns-Manville Ring-Tite, or equal.
 3. Copper:
 - a. Fittings: ASTM B 75, cast copper or ANSI B16.22, wrought copper.
 - b. Joints: Compression connection or AWS A5.8, BCuP silver braze.
 4. Polyethylene:
 - a. Fittings: AWWA C901, molded or fabricated.
 - b. Joints: Compression.

2.05 VALVES

- A. Gate Valves: Gate valves shall be parallel seats, O-ring seals and 2-inch square operating nut; Mueller H-667 or equal.
1. Up to 3 Inches: Brass or bronze body, non-rising stem, inside screw, single wedge or disc, IPA ends with control rod, extension box, and valve key.
 2. 3 Inches and Over: AWWA C500, iron body, bronze trim, non-rising stem with square nut, single wedge, flanged or mechanical joint ends, control rod, extension box, and valve key.
- B. Butterfly Valves: AWWA C504, cast iron bodies, and stainless steel stems, and porcelain enamel coated ductile iron disc.
1. Minimum working pressure of not less than 150 psi.
- C. Check Valves: Swing check type, AWWA C508, mounted horizontally, and shall have cast iron discs with rubber-faced seat.
- D. Valve Boxes: Cast iron, slip adjustment type, in accordance with utility company requirements.
- E. Tapping Sleeve and Tapping Valve: Compatible with tapping machine used, and in accordance with utility company requirements.

2.06 FIRE PROTECTION

- A. Post Indicator Valve (PIV): Valve shall conform to Paragraph 2.03-A above, be UL approved, be designed for use with indicator post, and have flanged ends; Mueller A-2072, or approved equal. Each post indicator sprinkler control valve shall be equipped with a valve supervisory switch having SPDT contacts. Sprinkler Supervisory Devices shall be PIVS, installed under Division 13.
- B. Indicator Post: Indicator post shall be UL approved and designed for use with indicator valve; Mueller A-20800, or equal.
- C. Fire Department Connection: Fire department connection shall be horizontal type with dual clappered inlets, red plastic plugs, and a sign with raised letters reading **AUTOMATIC SPRINKLER**. Provide check valve.
- D. Fire Hydrant: In accordance with Contract Drawings.

2.07 ACCESSORIES

- A. Water Meter: Provide water meter conforming to the standard specifications of governing agency having jurisdiction.
- B. Water Meter: Provided by public agency or water utility and installed by Contractor.
- C. Water Meter: Existing.
- D. Backflow Prevention Assembly: Reduced pressure principle type manufactured with resilient seated shut-off valves.
 - 1. Conform to standard specifications of public utilities department having jurisdiction.
- E. Concrete Mix for Thrust Blocks: Not leaner than 1 part cement, 2-1/2 parts sand, 5 parts stone, with a compressive strength of not less than 2000 psi at 28 days.
- F. Rust Proofing: Bitumastic No. 50, as manufactured by Koppers or equal.

2.08 IDENTIFICATION

- A. Warning Tape: Polyethylene plastic tape, 6 inches wide by 4 mils thick, solid *blue* in color with continuously printed caption in black letters **CAUTION—WATER LINE BURIED BELOW**.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Trenching, Backfilling, And Compacting: Refer to Section 312300.
- B. Carefully inspect all pipe for defects before any length of pipe is laid. No pipe or other material that is cracked or otherwise defective shall be installed.
- C. Soil Corrosivity: Comply with soil report recommendations regarding corrosion and cathodic protection and isolation from concrete and reinforcing steel, as applicable.

3.02 PIPE INSTALLATION

A. General:

1. Use ductile iron pipe under footings.
 - a. Provide 30-inch cover typically.
 - b. Provide 36-inch cover where surface loads exist.
2. All pipe shall be laid true to line and grade.
3. Pipe shall be given a solid uniform bearing in the bottom of the trench. Blocking or supporting pipe on earth mounds will not be permitted.
4. Whenever it is necessary to use a short length of pipe at a fitting or valve, the minimum length shall be 32 inches. If it is necessary to cut pipe, the cut shall be made with an approved pipe cutter. The use of hammer and chisel for pipe cutting will not be permitted.
5. Install an 8 gage solid copper wire in the trench with non-metallic pipe. The wire may be either bare or insulated and shall be laid along the top of the initial backfill so that there is no direct contact between the copper and any other metal in the trench.
6. There shall be a minimum 2 inches clearance where pipes penetrate foundation walls, concrete walkways.
7. Install identification warning tape 6 to 8 inches below finish grade above all water distribution lines.

B. Debris Control:

1. All pipe, valves, and fittings shall be carefully wiped out and cleaned as they are installed. Any earth or rubbish which may have lodged inside during or before laying shall be removed.
2. Every open end of installed pipe shall be capped or plugged with an approved fitting at all times when work is suspended, at the close of the work day, and as directed by the Architect.

3.03 FIRE SPRINKLER SERVICE LINE INSTALLATION

A. General:

1. Water supply mains shall have at least 3.5 feet of cover from top of pipe to finish grade unless otherwise specified or shown on the Drawings.
2. All trenches shall be excavated to a grade 6 inches below the bottom of the pipe.
3. Pipe shall be laid in a bed of clean mixture of 3/4-inch crushed gravel-sand having a sand equivalent of not less than 35, and a maximum aggregate size of 1/2-inch.
4. Bedding material shall be spread on the full width of the trench and compacted to 90 percent of maximum density by means of mechanical tampers to form a smooth, firm uniform support for the pipe or conduit.
5. Pipe shall not be laid until the bedding has been inspected and approved.
6. After testing and acceptance, the trench shall be backfilled with sand to a point 10 inches above bottom of pipe. It shall then be wetted and hand tamped, refilled with sand to approximately 12 inches above top of pipe, wetted again, and hand tamped firm. Mechanical tamping of rock-free soil shall be carefully done to achieve a minimum of 90 percent compaction.

7. Requirements for backfilling from 12 inches above the pipe to finish grade:
 - a. At drives and to 5 feet beyond pavement edge, compaction shall be 90 percent maximum to within 2 feet of finish grade and 95 percent in the top 2 feet.
 - b. At other areas, backfill shall be approved excavated material compacted to 90 percent of maximum density. The top of the trench backfill shall be slightly mounded to prevent formation of a depression due to settlement in the backfill.
8. Concrete shall produce an effective bearing area against undisturbed earth equal to that indicated in the applicable tables and drawings in NFPA 24, but in no case less than areas indicated above. Fittings used for vertical changes in alignment shall be restrained by uplift anchors of design approved by the Architect.
9. Tie rods shall be installed and shall be coated with rust protecting material as approved by Architect.
10. Prior to backfilling, all exposed metal surfaces shall be thoroughly coated with two coats of rust proofing.

3.04 CONNECTION TO EXISTING MAIN

- A. Newly installed facilities shall be kept isolated from the system until connections are bacteriologically acceptable. If isolation is provided by a closed gate valve, pressure testing for leakage in the new facilities shall be conducted before bacteriological acceptance.
- B. The Architect will designate method and sequence of connecting to existing mains to minimize contamination danger. Connections to existing valves prior to obtaining satisfactory leakage and pressure tests of the new facilities shall be at the Contractor's risk.

3.05 THRUST BLOCK INSTALLATION

- A. Thrust blocks shall be provided for all pressure pipe fittings, and at changes in direction and at all other points where there is a possibility of joint separation under pressure. Concrete shall bear against undisturbed soil.
- B. Provide not less than 2 square feet of bearing area for changes of direction up to and including 45 degrees. Provide no less than 6 square feet of bearing area for changes of direction greater than 45 degrees.
- C. Backfilling operations may begin as soon as the concrete has set sufficiently to remain in position and withstand the weight of the earth. Concrete shall not be disturbed or pressure loaded for at least 5 days after placing.

3.06 HYDRANT

- A. Install fire hydrant 18 inches behind curb face and 3 feet minimum clear above ground.

3.07 STERILIZATION

- A. General:
 1. All lines, mains, and branches shall be sterilized by chlorination in accordance with AWWA C651 and as herein specified. Chlorine (CL) shall be a 1 percent solution (containing 10,000 parts per million

available chlorine) or shall be obtained by use of dry chlorine in tablet form firmly attached to interior walls of the pipe.

2. The weight of chlorine or chlorine compound required to make a 1 percent chlorine solution is as follows:

CHLORINE COMPOUND	QUANTITY	WATER (gallons)
High-Test Calcium	1 pound	7.50
Liquid Chlorine (100% CL)	0.62-pound	7.50
Hyprochlorite (65-70% CL)	2 pounds	7.50
Chlorinated Lime (32-35% CL)	4 pounds	7.50
Liquid Laundry Bleach (5.25% CL)	1 gallon	4.25

3. The required concentration of chlorine in the pipe is 50 parts per million. This concentration may be attained by adding 5 gallons of the chlorine solution to 1,000 gallons of water

- B. Liquid Chlorine Solution Method: Foreign matter shall be flushed from mains, branch runs, hydrant runs, and installed services. Liquid chlorine solution shall be introduced at appropriate locations to ensure uniform distribution through the facilities at the proper concentration. Installed copper service lines shall not be used to convey the concentrated solution to the mains. The sanitizing solution shall be retained in the facilities for a period of 24 hours after which each service, hydrant run, branch run, and dead end shall be flushed until the residual chlorine is less than one part per million or is no greater than the concentration of chlorine in the water supplied for flushing.
- C. The required concentration of chlorine in the mains may be obtained by the use of HTH tablets as produced by Olin Mathieson in the following quantities:

NO. OF TABLETS PER LENGTH OF PIPE FOR 70% DOSAGE					
Length Of Pipe (Feet)	Diameter Of Pipe				
	4"	6"	8"	10"	12"
13	1	2	2	3	5
18	1	2	3	5	6
20	1	2	3	5	7
30	2	3	5	7	10
36	2	3	5	8	12
40	2	4	6	9	14
100	4	9	15	23	30

- D. HTH Tablet Method: Tablets shall be fastened to the inside top surface of each length of pipe using hot tar equal to Permatex No. 1 at time of pipe laying. Tablets shall not be available at any time for casual pilferage by the general public or by children. The new facilities shall be slowly filled with water. Air is to be exhausted from each dead end, branch run,

hydrant run, and installed service. Water shall be retained for a period of 24 hours, after which each service, hydrant run, branch run, and dead end shall be thoroughly flushed to clear foreign matter until the residual chlorine concentration is less than one part per million or is no greater than the concentration of chlorine in the water supplied for flushing.

- E. Bacteriological Testing: Samples shall be gathered and tests conducted at the expense of the Contractor by a laboratory approved by the Architect. Samples are to be taken at representative points as required by the Architect.
- F. The facilities shall remain isolated and out of service until satisfactory test results have been obtained that meet the requirement of the governing Department of Public Health and until the Architect has accepted the results as indicative of the bacteriological condition of the facilities. If unsatisfactory or doubtful results are obtained from the initial sampling, the chlorination process shall be repeated until acceptable test results are reported.

3.08 FIELD QUALITY CONTROL

- A. Hydrostatic Pressure Tests:
 - 1. After the pipe has been laid and backfilled, it shall be subjected to hydrostatic pressure tests. All joints shall be exposed during testing. Tests shall not be conducted until at least 12 hours have elapsed since pipe laying and at least 5 days have elapsed since placing of concrete thrust blocks. Pipe shall be filled with water and remain without external application of pressure for 24 hours before tests are conducted.
 - 2. Prior to hydrostatic testing, pipe system shall be flushed with fresh water until piping is free of dirt and foreign matter.
 - 3. Pressure shall be applied by means of a pump in a manner satisfactory to the Architect, and measured by means of a test gauge. All necessary apparatus and labor for conducting the pressure and leakage tests shall be furnished by the Contractor.
 - 4. It is the Contractor's responsibility to ensure the release of air from the line during filling, as well as the prevention of collapse due to vacuum when dewatering the line.
 - 5. For pressure test, use a hydrostatic pressure 50 psi greater than the maximum working pressure of the system, but not less than 200 psi. Hold this pressure for at least 4 hours.
- B. Testing for Fire Sprinkler Service Lines:
 - 1. Fire system sprinkler service lines and appurtenances shall be subjected to pressure and leakage tests and shall satisfactorily pass such tests before acceptance. Test pressure shall be not less than 200 psi and shall be maintained for a period of not less than 2 hours.
 - 2. Hydrostatic test and leakage test shall be in accordance with NFPA 13, with the following modifications:
 - a. Contractor shall make taps and provide labor, equipment, and instruments to perform the tests.
 - b. Water for test shall be made available to the Contractor through connection to the existing site water system.

- c. Contractor shall provide taps for venting air for test purposes in addition to those provided as part of the permanent system.
- d. No leakage will be permitted. The Contractor shall investigate and discover the cause of leaks and make corrections necessary to the satisfaction of the Architect.
- e. The hydrostatic and pressure tests at the specified test pressure shall be made after the line is completed and the piping is center-loaded.
- f. All flushing shall be satisfactorily completed prior to any connection to the risers of the overhead sprinkler system.
- g. All tests and flushings shall be witnessed by the Fire Marshal and Architect. The Fire Marshal and Architect shall be given 24 hours notice prior to each test.
- h. Three copies of a properly executed and completed testing and flushing certificate shall be delivered to the Architect.

END OF SECTION