

**SECTION 02 4116
SELECTIVE DEMOLITION**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Furnishing labor, materials and equipment necessary for demolition, dismantling, cutting and alterations as indicated, specified, or required for completion of the Work. Includes items such as the following:
 - 1. Protection of existing improvements to remain.
 - 2. Cleaning existing improvements to remain.
 - 3. Disconnecting and capping utilities.
 - 4. Removing debris, waste materials, and equipment.
 - 5. Removal of items for performance of the Work.
 - 6. Salvageable items to be retained by the Owner.
- B. Related Requirements:
 - 1. Division 01 - General Requirements.
 - 2. Section 01 1100 - Summary of Work.
 - 3. Division 26 — Electrical.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings indicating the extent of items and systems to be removed. Indicate items to be salvaged or items to be protected during demolition. Indicate locations of utility terminations and the extent of abandoned lines to be removed. Include details indicating methods and location of utility terminations.

1.03 QUALITY ASSURANCE

- A. Perform the Work of this section by workers skilled in the demolition of buildings and structures. Perform the Work of this section under direct superintendence at all times.
- B. Prior to commencement of Work, schedule a walkthrough with the OAR, to confirm Owner property items have been removed from scheduled Work areas. Identify and mark remaining property items and schedule their removal.
- C. Coordinate demolition for the correct sequence, limits, and methods. Schedule demolition Work to create least possible inconvenience to the public and facility operations.
- D. Related Standard: ANSI/ASSE A10.6.

1.04 PROJECT CONDITIONS

- A. Drawings may not indicate in detail all demolition Work to be performed. Examine existing conditions to determine the full extent of required demolition.
- B. Repair damage to existing improvements or damage due to excessive demolition.
- C. Provide all measures to avoid excessive damage from inadequate or improper means and methods, improper shoring, bracing or support.
- D. If conditions are encountered that varies from those indicated, promptly notify the Architect for clarification before proceeding.

PART 2 - PRODUCTS

2.01 HANDLING OF MATERIALS

- A. Items scheduled for salvage by the Owner shall be delivered to a location designated by the OAR. Items shall be cleaned, packaged and labeled for storage.
- B. Items scheduled for reuse shall be stored on the Project site and protected from damage, theft and other deleterious conditions.

PART 3 - EXECUTION

3.01 GENERAL

- A. Protection:
 - 1. Do not commence demolition until safety partitions, barricades, warning signs and other forms of protection are installed.
 - 2. Provide safeguards, including warning signs, lights and barricades, for protection of workers, occupants, and the public.
- B. If safety of existing construction appears to be endangered, take immediate measures to correct such conditions; cease operations and immediately notify the OAR.

3.02 DEMOLITION

- A. Do not throw or drop materials. Furnish ramps or chutes as required by the Work.
- B. Remove existing construction only to extent necessary for proper installation of Work and interfacing with existing construction. Cut back finished surfaces to straight, plumb or level lines as required for a smooth transition.
- C. Where openings are cut oversize or in improper locations, replace or repair to required condition.

3.03 CUTTING EXISTING CONCRETE

- A. Cutting of existing concrete shall be performed by skilled workers familiar with the requirements and space necessary for placing concrete. Perform concrete cutting with concrete cutting wheels and hand chisels. Do not damage concrete intended to remain.

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- B. Extent of cutting of structural concrete shall be as indicated on Drawings. Cutting of non-structural concrete shall be as indicated on Drawings or as reviewed by the Architect or structural engineer. Replace concrete demolished in excess of amounts indicated.
- C. Prior to cutting or coring concrete, determine locations of hidden utilities or other existing improvements and provide necessary measures to protect them from damage.
- 3.04 REMOVAL OF EXISTING PLUMBING AND ELECTRICAL EQUIPMENT AND SERVICES
 - A. Remove existing plumbing and electrical equipment fixtures and services not indicated for reuse and not necessary for completion of the Work. Remove abandoned lines and cap unused portions of existing lines.
- 3.05 REMOVAL OF OTHER MATERIALS
 - A. Masonry: Cut back to joint lines and remove mortar without damaging units to remain. Allow space for repairs to backing where applicable.
 - B. Woodwork: Cut or remove to a joint or panel line.
 - C. Roofing: Remove as required, including accessory components such as insulation and flashings. At penetrations through existing roofing, trim cut edges back to sound roofing with openings restricted to the minimum size necessary to receive Work.
 - D. Sheet Metal: Remove back to joint, lap, or connection. Secure loose and unfastened ends or edges and provide a watertight condition. Re-seal as required.
 - E. Glass: Remove broken or damaged glass and clean rebates and stops of glazing channels.
 - F. Modular materials such as acoustical ceiling panels, resilient tile, or ceramic tile: Remove to a natural joint without leaving damaged or defective Work where joining new Work. After flooring removal, clean substrates to remove setting materials and adhesives.
 - G. Gypsum Board: Remove to a panel joint line on a stud or support line.
 - H. Plaster: Saw cut plaster on straight lines, leaving a minimum 2-inch width of firmly attached metal lath for installing new lath and plaster.
 - I. Remove existing improvements not specifically indicated or required but necessary to perform Work. Cut to clean lines, allowing for installation of Work.
- 3.06 PATCHING
 - A. Patch or repair materials to remain when damaged by the performance of the Work of this section. Finish material and appearance of patch and/or repair Work shall match existing.
- 3.07 CLEANING
 - A. Clean existing materials to remain with appropriate tools and equipment.
 - B. Protect existing improvements during cleaning operations.

- C. Debris shall be dampened by fog water spray prior to transporting by truck.
- D. Debris pick-up area shall be kept broom-clean and shall be washed daily with clean water.
- E. Remove waste and debris, other than items to be salvaged. Turn over salvaged items to Owner, or store and protect for reuse where required. Continuously clean up and remove items as demolition Work progresses.
- F. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

**SECTION 03 1000
CONCRETE FORMING**

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Design and construction of formwork for concrete.
2. Setting in forms, all anchor bolts, metal inserts, sleeves, etc., embedded in concrete.
3. Miscellaneous concrete work, including but not limited to areaways, cast-in-place valve boxes, pits, splash blocks, equipment bases, and other items as shown or required to complete all work.

B. Related Sections:

1. All Pertinent Provisions of Division 01, "General Requirements."
2. Section 03 20 00: Concrete Reinforcement.
3. Section 03 30 00: Cast-In-Place Concrete
4. Section 31 10 00: Site Clearing
5. Section 31 20 00: Earth Moving

C. Related Work Specified Elsewhere:

1. Finishing and final curing of cast-in-place concrete.
2. Placing of embedded anchor bolts and inserts.
3. Gravel fill under interior floor slabs.
4. Cement fill in metal stair pans.
5. Trench grates
6. Screeds for slabs.

1.02 SUBMITTALS

A. Comply with pertinent provisions of Division 01 Section "Submittal Procedures".

B. Shop Drawings: Submit shop drawings showing form pattern layouts of all exposed exterior and interior concrete dimensioned to precisely locate grooves, form panel jointing, bulkhead formwork detail at construction joints and similar features. Review and approval will not include form strength and adequacy.

C. Record Document: Keep an accurate record of the dates of removal of forms, form shores and reshores, and furnish copies to the SEOR and Owner.

D. Submit product data for all proprietary items to be used on project.

1.03 QUALITY ASSURANCE

- A. Comply with pertinent provisions of Division 01, Section 01 43 00, "Quality Assurance Requirements."
- B. Construct forms according to ACI 347, "Guide to Formwork for Concrete," and conforming to tolerances specified in ACI 301, "Specifications for Structural Concrete," as applicable, unless exceeded by requirements of AUTHORITY HAVING JURISDICTION or otherwise indicated or specified.
- C. Prior to construction of formwork for concrete beams and slabs above grade, General Contractor shall conduct a meeting at the site to determine and define all camber which may be required for the project. The Architect, Structural Engineer of Record, General Contractor, Contractor and Contractor's formwork installer shall be in attendance at this meeting.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Comply with pertinent provisions of Division 01, Section 01 61 00, "Common Product Requirements."
- B. Deliver materials for forms in timely manner to ensure uninterrupted progress.
- C. Store materials by methods that prevent damage and permit ready access for inspection and identification.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Form lumber: Lumber with adequate strength, stiffness, dimensional accuracy and stability, workability, and durability in conformance with ACI 347 "Guide to Formwork of Concrete."
- B. Form plywood: PS 1-95, Group I, Exterior Grade B-B Plyform or better, minimum 5-ply and 3/4" thick for exposed locations and not less than 5/8" thick for unexposed locations, grade marked, not mill oiled. Plywood having medium or high density overlay is acceptable.
- C. Coated form plywood: For exposed painted concrete, plastic overlaid plywood of grade specified above, factory coated with a form coating and release agent "NoxCrete", or equal.
- D. Tube forms: Sonoco "Seamless Sonotubes", or approved equal, type leaving no marks in concrete, 1-piece lengths for full required heights.
- E. Joist forms: Approved steel or molded plastic types as required.
- F. Special forms: For exposed integrally-colored concrete, plywood as above with high density overlay, plywood with integral structural hardboard facing or fibrous glass reinforced plastic facing, or approved equal producing specified finish.
- G. Form ties: Prefabricated rod, flat band, wire, internally threaded disconnecting type, or equal, not leaving metal within 1-1/2" of concrete surface.
- H. Form coating: Non-staining clear coating free from oil, silicone, wax, not grain-raising, "Cast-Off" by BASF or equal approved equal by the SEOR. Where form liners are used, provide form coatings recommended by form liner manufacturer.

- I. Form liner: Rigid or resilient type by Labrado Forms, Symons, or approved equal, types shown or directed, matching approved sample.

PART 3 - EXECUTION

3.01 WORKMANSHIP

- A. Rigidly construct forms to prevent mortar leakage, sagging, displacement or bulging between studs. Use clean, sound, approved form material, coated with specified materials only, not oil. Provide backing on all plywood joints.
- B. Sides of all footings and grade beams shall be formed or cast against clean vertical cuts in unweathered bedrock, unless the member detail provides at least 3" clear cover to reinforcement and indicates that the member is cast against earth, or permission is obtained to place concrete directly against earth. Where this permission is granted, the footing or grade beam dimension shall be increased 3". Remove formwork prior to backfilling operations.

3.02 FORM ERECTION AND REMOVAL

- A. Conform to ACI 301, ACI 318 and ACI 347 except as exceeded by the requirements of AUTHORITY HAVING JURISDICTION or herein.
- B. Construction: Coat forms with the specified resin coating, not form oil. Construct forms to exact shapes, sizes, lines, and dimensions required to obtain level, plumb, and straight surfaces. Provide openings, offsets, keys, reglets, anchorages, recesses, moldings, chamfers, blocking, screeds, drips, bulkheads, and all other required features. Make forms easily removable without hammering or prying against concrete. Space forms apart with metal spreaders. Construct forms to accurate alignment, location and grades, and provide against sagging, leakage of concrete mortar, or displacement occurring during and after placing of concrete. Coordinate installation of inserts and anchors in forms according to Shop Drawings and requirements for work of other sections.
- C. Camber: Place suitable jacks, wedges, or similar means to induce camber and to correct settlement in forms before and during concrete placing. Camber shall be as determined in pre-installation meeting specified above. In general, formwork shall be capable of accommodating camber of 1/8" per 10' of span plus 1/4". Provide camber as noted on the Structural Drawings (if required).
- D. Corners and Angles: Provide 3/4" by 3/4" beveled chamfer strips for all exposed concrete corners and angles unless otherwise indicated. Form concealed concrete corners and angles square unless otherwise indicated.
- E. Reglets and Rebates: Form required reglets and rebates to receive frames, flashing, and other equipment. Obtain required dimensions, details, and precise positions for work to be installed under other sections and form concrete accordingly.
- F. Form Joints: Fill joints to produce smooth surfaces, intersections, and arises. Use polymer foam or equivalent fillers at joints and where forms abut or overlap existing concrete to prevent leakage of mortar.
- G. Recesses, Drips, and Profiles: Provide smooth milled wood or pre-formed rubber or plastic shapes of types shown and required.

- H. Cleanouts and Cleaning: Provide temporary openings in all wall forms and other vertical forms for cleaning and inspection. Clean forms and surfaces to receive concrete prior to placing.
- I. Re-Use: Clean and recondition form material before re-use.
- J. Form Removal: Do not remove concrete forms until concrete attains sufficient strength to support its own weight and all superimposed loads as determine by testing field cured concrete cylinders, but not sooner than specified in ACI 347, Section 3.6.2.3, or ACI 318, Section 26.11. Load supporting forms may be removed when concrete has attained 75 percent of required 28 day compressive strength, but no sooner than 3 days, provided construction is reshored. Vertical formwork for cast-in-place concrete walls may be removed no sooner than 1 day following concrete placement, provided that contractor can demonstrate that no sloughing or sagging of concrete will occur.
 - 1. Reshore structural members as specified per ACI 347.
 - 2. Remove formwork progressively so unbalanced loads are not imposed on the structure.
 - 3. Avoid damage to concrete surfaces during form removal.
 - 4. Store reusable forms for exposed architectural concrete to prevent damage to contact surfaces.
 - 5. Remove formwork in same sequence as concrete placement to achieve similar concrete surface coloration.
- K. Reshoring:
 - 1. Minimum reshoring shall be as per the requirements of ACI 347.
 - 2. Record: Maintain a form and shoring removal record.
 - 3. Contractor shall submit shoring/reshoring plans and calculations for review and approval by the SEOR. Calculations and plans shall be stamped and signed by a licensed structural engineer registered in the State of California. Reshoring loads to the lower floors shall be consistent with the design loads specified on the construction documents and with the acquired strength of the lower floors based on the time they have been allowed to cure before being loaded.
- L. Shoring for Tributary Loads: Set temporary shoring for structural steel beams supporting cast-in-place concrete beams, walls, or slabs.

3.03 FORMWORK TOLERANCES

- A. Deflection: Limit deflection of forming surfaces from concrete pressure to $L/240$.
- B. Finish Lines: Position formwork to maintain hardened concrete finish lines within following permissible deviations.
 - 1. Variation from Plumb:

In 10'-0"	1/4 inch
In any story or 20'-0"	3/8 inch
In 40'-0" or more	3/4 inch
 - 2. Variation from Level or Grades Indicated

In 10'-0"	1/4 inch
In any bay or 20'-0" maximum	3/8 inch
In 40'-0" or more	3/4 inch

3. Cross-Sectional Dimensions

Minus	1/4 inch
Plus	1/2 inch

C. Building Lines: Variation of linear building lines from established position in plan and related position of columns, walls and partitions:

1. In any bay or 10'-0" maximum	1/2 inch
In 40'-0" or more	1 inch

D. Slab Openings: Variations in size and location of sleeves and slab openings shall not exceed 1/4 inch.

3.04 SURVEY AND ADJUSTMENT

A. Check forms before and during placement of concrete, using an instrument, and make corrections as work proceeds.

3.05 EMBEDDED PIPING AND ROUGH HARDWARE

A. Comply with ACI 318, Section 26.11. Where work of other sections require openings for passage of pipes, conduits, ducts, and other inserts in the concrete, obtain all dimensions and other information. All necessary pipe sleeves, anchors, or other required inserts shall be accurately installed as part of the work of other sections, according to following requirements. See specification Section 03 30 00, Section 1.3.B for submittal requirements related to this scope.

B. Conduits or Pipes: Locate so as not to reduce strength of concrete. Do not place pipes, other than conduits, in a slab 4-1/2" thick or less in any case. Conduit buried in a concrete slab shall not have an outside diameter greater than 1/3 the slab thickness nor be placed below the bottom reinforcing steel or over top reinforcing steel.

C. Sleeves: Pipe sleeves may pass through slabs or walls if not exposed to rusting or other deterioration and are of uncoated or galvanized iron or steel. Provide sleeves of diameter large enough to pass any hub or coupling on pipe, including any insulation. Refer to Architectural and MEP drawings and specifications for details of waterproofing seals at wall penetrations.

D. Conduits: Conduits may be embedded in walls only if the outside diameter does not exceed 1/3 the wall thickness, are spaced no closer than 3 diameters on centers, and do not impair the strength of the structure.

E. Clusters of Conduits:

1. Clusters of conduits embedded in a concrete slab shall not exceed 6 conduits per cluster and each conduit per cluster shall be individually spaced as per the above requirements. Conduit clusters exceeding this requirement shall be reviewed and approved by the Structural Engineer of Record and AUTHORITY HAVING JURISDICTION prior to the installation of the conduits.

2. If more than one conduit cluster is required in a specific area of the slab, routing and spacing of the clusters shall be reviewed and approved by the structural engineer of record and AUTHORITY HAVING JURISDICTION prior to the installation of the conduits.
3. At no time shall the quantity and routing of clusters of conduits impair the strength of the concrete construction.

3.06

FIELD QUALITY CONTROL

- A. Inspection: Obtain inspection and approval of forms per 2019 CBC Table before placing structural concrete. Comply with the general provisions of Division 01, Section 01 43 00, "Quality Assurance Requirements."

END OF SECTION

SECTION 03 2000
CONCRETE REINFORCING

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 concrete reinforcement for the following:

1. Mat foundation.
2. Foundation walls.
3. Slabs-on-grade.
4. Concrete Toppings.
5. Concrete Masonry Units.

- B. Related Sections:

1. Section 031000 "Concrete Forming and Accessories"
2. Section 033000 "Cast-In-Place Concrete"

1.03 REFERENCES

- A. Abbreviations & Acronyms

1. ACI – American Concrete Institute
2. CRSI – Concrete Reinforcing Steel Institute

- B. Reference Standards

1. ACI 301-10: Specification for Structural Concrete Buildings.
2. ACI 117-10: Specification for Tolerances for Concrete Construction and Materials.

1.04 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 Section "Administrative Requirements."

- B. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1. Provide details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include special reinforcement required for openings through concrete structures.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For welder

- B. Welding certificates.

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- C. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Steel reinforcement and accessories.
- 1.06 QUALITY ASSURANCE
- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301-10, "Specifications for Structural Concrete for Buildings"
 - 2. ACI 117-10, "Specification for Tolerances for Concrete Construction and Materials"
 - B. CRSI Publications: Comply with the following, unless more stringent provisions are indicated:
 - 1. Manual of Standard Practice
 - 2. Documents 63 and 65.
 - C. Qualifications
 - 1. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
- 1.07 DELIVERY, STORAGE, AND HANDLING
- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

- 2.01 STEEL REINFORCEMENT
- A. Reinforcing Bars: See Structural Drawings
 - B. Plain-Steel Wire: See Structural Drawings
 - C. Deformed-Steel Wire: See Structural Drawings
- 2.02 DEFORMED BAR ANCHORS
- A. Nelson, Type D2L automatically end-welded deformed bar
- 2.03 REINFORCEMENT ACCESSORIES
- A. Tie Wire: Minimum 16 gage, ASTM A 82, or acceptable patented system.
 - B. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
 - C. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.
 - D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
- 2.04 FABRICATING REINFORCEMENT
- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.01 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 - 1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Defective Work: The following reinforcing steel work will be considered defective, and shall be removed and replaced by the Contractor at no additional cost to the Owner:
 - 1. Bars with kinks or bends not shown on the drawings.
 - 2. Bars damaged due to bending or straightening.
 - 3. Bars heated for bending.
 - 4. Reinforcement not placed in accordance with the drawings.

3.02 DEFORMED BAR ANCHOR INSTALLATION

- A. Install in accordance with ICC ESR-2907

3.03 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. All concrete work is subject to special inspection and testing. This section specifies the minimum testing and inspection required. Additional testing and inspection may be required by the Testing Agency, the Owner, or the Engineer/Architect if project conditions warrant.
- C. Special Inspector Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, and qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- D. Tests and inspections shall be in conformance with Division 1, Section "Quality Requirements".
- E. Independent Testing Agency shall check batch tickets for compliance with required mix design(s).
- F. Inspections:
 - 1. Steel reinforcement placement.
 - 2. Steel reinforcement welding.
- G. Reinforcing Steel Testing: Independent Testing Agency will perform the following:
 - 1. All steel bars that can be positively identified as to heat number and mill analysis shall have one tensile test bending test for each 10 tons, or fraction thereof, for all #5 bars and larger.

2. All steel bars that cannot be identified shall have one tensile and one bend test made for each 2 1/2 tons, or fraction thereof, of each size and kind of reinforcing steel.
 3. Testing procedure shall conform to ASTM A 615.
- H. Reinforcement Welding: All shop and field welds of reinforcing steel will be inspected. The Special Welding Inspector will check the materials and equipment, the qualifications and ability of the welder, and details of construction and procedure, as well as the welds themselves. The Inspector may use gamma ray, magneflux, trepanning, ultrasonics, or any other aid to visual inspection which the Inspector may deem necessary to determine the adequacy of the welding.
- I. No concrete shall be placed until placement of reinforcement steel has been inspected and approved. Provide 48 hours notice to the Inspector prior to placing concrete.

END OF SECTION

SECTION 03 3000
CAST-IN-PLACE CONCRETE

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 cast-in-place concrete, including, concrete materials, mixture design, placement procedures, and finishes, for the following:

- 1. Mat foundation.
- 2. Foundation walls.
- 3. Slabs-on-grade.
- 4. Concrete Toppings.

- B. Related Sections:

- 1. Section 031000 "Concrete Forming and Accessories"
- 2. Section 032000 "Concrete Reinforcing"

1.03 REFERENCES

- A. Abbreviations & Acronyms

- 1. ACI – American Concrete Institute
- 2. NRMCA – National Ready Mixed Concrete Association

- B. Definitions

- 1. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
- 2. W/C Ratio: The ratio by weight of water to cementitious materials.

- C. Reference Standards

- 1. ACI 301-10: Specification for Structural Concrete Buildings.
- 2. ACI 117-10: Specification for Tolerances for Concrete Construction and Materials

1.04 ADMINISTRATIVE REQUIREMENTS:

- A. Steel and Concrete Preconstruction Coordination Meeting: Conduct coordinate meeting at project site a minimum of 3 weeks prior to submitting any shop drawings or procurement of materials.
 - 1. Require representatives of each entity directly concerned with steel fabrication and erection and concrete placement to attend, including but not limited to the following:
 - a. Construction Manager
 - b. Steel Fabricator
 - c. Steel Erector

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- d. Concrete Contractor
- e. Structural Engineer of Record
- f. Architect of Record
- 2. Review and coordinate the following:
 - a. Anchor rod installation requirements and tolerances
 - b. Method for securing anchor rods against movement during concrete placement
 - c. Steel Embed Plates
 - d. Submittal Schedules
 - e. Critical Path and Long Lead Items
 - f. Any and all items that require cross-trade coordination

B. Preinstallation Meeting: Conduct meeting at project site

- 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Construction Manager
 - b. Independent testing agency responsible for concrete design mixtures
 - c. Ready-mix concrete manufacturer
 - d. Concrete contractor
 - e. Special concrete finish contractor
 - f. Structural Engineer of Record
 - g. Architect of Record
- 2. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Concrete finishes and finishing.
 - c. Cold- and hot-weather concreting procedures.
 - d. Curing procedures.
 - e. Construction contraction and isolation joints.
 - f. Forms and form removal limitations.
 - g. Shoring and re-shoring procedures.
 - h. Vapor-retarder installation.
 - i. Anchor rod and anchorage device installation tolerances.
 - j. Steel reinforcement installation.
 - k. Floor and slab flatness and levelness measurement.
 - l. Concrete repair procedures.

- m. Concrete protection.

1.05

ACTION SUBMITTALS

- A. Submit in accordance with Division 01 Section "Administrative Requirements."
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Submit proposed mix designs at least 15 days in advance of placing operations for each concrete mixture. The submitted mix design shall include the following:
 - a. Supporting strength test data not more than 12 months old. At the Engineer's request, reports from the independent testing agencies may be required to document the test data. Reports from the independent testing agencies will be required if fly ash is used in the design mix.
 - b. Statistical analysis in compliance with ACI 301.
 - c. Gradation of fine and coarse aggregates not more than 90 days old (ASTM C 33). No substitution of aggregate type or size from those submitted will be permitted.
 - d. Proportions of all ingredients, including all admixtures added either at time of batching or at job site. Aggregate weights shall be based upon saturated surface dry conditions.
 - e. Water/cement ratio.
 - f. Slump (ASTM C 143): When high range water-reducing admixtures are used, slump before and after addition of admixture are required.
 - g. Air content of freshly mixed concrete (ASTM C 231).
 - h. Material Certificates for the following:
 - 1) Cementitious Materials
 - 2) Admixtures
 - i. Certification that all ingredients in each mix design are compatible
 - j. Locations or intended use of each mix design.
 - k. Source of all materials.
 - l. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Embedded Item Placement Drawings: Drawings indicating the location and type of plates, anchorages, or other items to be embedded in the finished concrete surfaces. Include wall elevations, slab plans, and details required to locate and install embeds.
- D. Samples: For waterstops and vapor retarder.
- E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - 1. Location of construction joints is subject to approval of the Architect.

1.06

INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer, and testing agency.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:

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1. Form materials and form-release agents.
 2. Steel reinforcement and accessories.
 3. Waterstops.
 4. Curing compounds.
 5. Floor and slab treatments.
 6. Bonding agents.
 7. Adhesives.
 8. Semirigid joint filler.
 9. Joint-filler strips.
 10. Repair materials.
- D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- E. Written curing procedure, including curing procedures for hot- and cold-weather placement.
- F. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- G. Field quality-control reports.
- H. Minutes of preinstallation conference.
- 1.07 QUALITY ASSURANCE
- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301-10, "Specifications for Structural Concrete for Buildings"
 2. ACI 117-10, "Specification for Tolerances for Concrete Construction and Materials"
- B. CRSI Publications: Comply with the following, unless more stringent provisions are indicated:
1. Manual of Standard Practice
 2. Documents 63 and 65.
- C. Qualifications
1. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
 2. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
 3. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

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- a. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
 - D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
 - E. Coordinate chemical and adhesion compatibility of curing compounds used for curing concrete with coatings, stains, paints, liquid flashings, sealers, waterproofing membranes, joint sealants and other materials that penetrate, adhere to or otherwise come into contact with concrete surfaces that are specified in other sections.
 - F. Batch Tickets: Provide batch tickets for review by inspector for each truckload of concrete used in the work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of cement and water introduced.
 - G. Concrete Finishing and Curing:
 - 1. Obtain each type, composition, and variety of liquid membrane-forming curing compound used for the Project from the same manufacturer.
 - 2. Products from more than one approved manufacturer may be used for different applications, however all products for like applications shall be by the same manufacturer.
 - 3. Liquid membrane curing compound manufacturer qualifications: Obtain materials only from a manufacturer that will send an experienced technical field representative to the Project site before the start of work to verify existing conditions, and during the execution of work to perform manufacturer's field services.
- 1.08 DELIVERY, STORAGE, AND HANDLING
- A. Store materials in accordance with ACI 301. Admixtures which have been in storage at the project site for longer than six months or which have been subjected to freezing shall not be used, unless retested and proven to meet the specified requirements.
 - B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.
- 1.09 FIELD CONDITIONS
- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - B. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
 - C. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Products: Subject to compliance with requirements, provide one of the products specified.
 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 1. Portland Cement: ASTM C 150, Type II Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class C.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 - c. Silica Fume: ASTM C 1240, amorphous silica.
- B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate, graded. Provide aggregates from a single source.
 1. Unless maximum aggregate size is listed specifically under "Project Mix Requirements," the maximum aggregate size shall not exceed:
 - a. Three-fourths of the minimum clear spacing between reinforcing bars.
 - b. One-fifth of the narrowest dimension between the sides of the forms.
 - c. One-third of the thickness of the slabs or toppings.
 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.

2.03 ADMIXTURES

- A. General
 1. Admixtures certified by manufacturer to contain not more than 0.05 percent water-soluble chloride ions by mass of cementitious material. Do not use admixtures containing calcium chloride or thiocyanate.

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2. Where more than one admixture is used in the mix, furnish manufacturer's certification to the Architect that the admixtures to be used are compatible in combination with the cement and aggregates.
 3. Accelerating admixtures shall not be used.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- D. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.
1. Products:
 - a. Axim Italcementi Group, Inc.; CATEXOL CN-CI.
 - b. BASF Construction Chemicals – Building Systems; Rheocrete CNI.
 - c. Euclid Chemical Company (The); Eucon, CIA.
 - d. Grace Construction Products, W.R. Grace & Co.; DCI.
 - e. Sika Corporation; Sika CNI.
- E. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
1. Products:
 - a. BASF Construction Chemicals – Building Systems; Rheocrete 222+.
 - b. Cortec Corporation; MCI [2000] [2005NS].
 - c. Grace Construction Products, W.R. Grace & Co.; DCI-S.
 - d. Sika Corporation; FerroGard-901.

2.04

WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513 for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
1. Profile: As indicated.
 2. Dimensions: 6 inches by 3/8 inch thick; nontapered.

- B. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.
- 2.05 VAPOR RETARDERS
- A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fortifiber Building Systems Group; Moistop Ultra 15
 - b. Meadows, W.R., Inc; Perminator 15 mil.
 - c. Raven Industries Inc.; Vapor Block 15.
 - d. Reef Industries, Inc; Griffolyn 15 Green
 - e. Stego Industries, LLC; Stego Wrap 15 mil Class A.
- 2.06 LIQUID FLOOR TREATMENTS
- A. Refer to section 033562 – Burnished Concrete Floor Finish
- 2.07 CURING MATERIALS
- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
 - B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
 - C. Water: Potable.
- 2.08 RELATED MATERIALS
- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber
 - B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.
 - C. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
 - D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- 2.09 REPAIR MATERIALS
- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
 4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2.10 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 25 percent.
 2. Combined Fly Ash and Pozzolan: 25 percent.
 3. Ground Granulated Blast-Furnace Slag: 50 percent.
 4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
 5. Silica Fume: 10 percent.
 6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
 7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- D. Slump: 4 inches plus or minus 1 inch
- E. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
- 2.11 CONCRETE MIXTURES FOR BUILDING ELEMENTS
- A. Concrete mix design shall comply with the requirements of the structural drawings.
- 2.12 CONCRETE MIXING
- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
 2. Install connection plates, angles, or other embedded items flush with concrete surface and at accurate locations per the approved embedded item placement drawings required by Part 1, "Submittals," section.

3.02 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

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5. Space vertical joints in walls at maximum of 30-foot spacing. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 8. Provide roughened surfaces at joints where shown on the drawings. Roughen to a full amplitude of approximately 1/4-inch.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. V-Grooved Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. V-Groove top with 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.
- 3.03 WATERSTOP INSTALLATION
- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.
- 3.04 VAPOR RETARDERS
- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
1. Place vapor retarder directly on top of granular course
 2. Lap joints 6 inches and seal with manufacturer's recommended tape.
- 3.05 CONCRETE PLACEMENT
- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- D. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.06

FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view or to receive a rubbed finish.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform

color and texture. Do not apply cement grout other than that created by the rubbing process.

2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.07

FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.
1. Apply scratch finish to receive mortar setting beds for bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces to receive trowel finish.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces indicated to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
- E. Broom Finish: Apply a broom finish to exterior concrete, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic rout. Coordinate required final finish with Architect before application.

3.08

MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

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- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

3.09 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surface to be burnished.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - c. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.

3.10 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged at least [one] [six] month(s). Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.11

CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete. Limit cut depth to 3/4 inch (19 mm). Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.
 - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 - 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 - 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.
- 3.12 FIELD QUALITY CONTROL
- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. All concrete work is subject to special inspection and testing. This section specifies the minimum testing and inspection required. Additional testing and inspection may be required by the Testing Agency, the Owner, or the Engineer/Architect if project conditions warrant.
- C. Special Inspector Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, and qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- D. Tests and inspections shall be in conformance with Division 1, Section "Quality Requirements".
- E. Independent Testing Agency shall check batch tickets for compliance with required mix design(s).
- F. Continuous Field Inspection: The Independent Testing Agency shall be present at all times during the placing of structural reinforced concrete. Work shall not proceed until all inspections are completed. Prior to placing concrete, the Inspector shall inspect:
1. Accuracy, configuration, and cleanliness of all formwork
 2. Quantity, cleanliness, and placement of all reinforcing steel.
 3. Testing Agency need not be present during entire reinforcing steel placing operations, provided he has inspected for conformance with the approved placement drawings prior to closing of forms or the delivery of concrete to the job site.
- G. Inspections:
1. Headed bolts and studs.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
- H. No concrete shall be placed until placement of reinforcement steel has been inspected and approved. Provide 48 hours notice to the Inspector prior to placing concrete.

- I. Concrete Sampling: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - b. At the Contractor's expense and direction, cast and field-cure standard cylinder specimens as may be required for construction. Number of specimens and testing age shall be determined by the Contractor based on construction sequence requirements.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 7. Test field-cured specimens at the Contractor's direction.
 8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
 10. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
 11. Linear Shrinkage Tests: Test for linear shrinkage in accordance with ASTM C 157 (air storage method for 28 days. Take a minimum of 3 test samples from each mix, at the Project Representative's direction, of concrete for elevated slabs and beams. Take samples at truck and discharge end of pumped mix. Consistency of the concrete must not be altered after test samples have been taken.

12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
 14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 15. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.
- J. Measure floor and slab flatness and levelness according to ASTM E 1155 within 8 hours of finishing.
1. Finish surfaces to the following tolerances, for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
 - b. Specified overall values of flatness, F(F) 30; with minimum local values of flatness, F(F) 24; for suspended slabs.
 - c. Specified overall values of flatness, F(F) 40; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for concrete receiving polished concrete finish.

3.13 PROTECTION OF LIQUID FLOOR TREATMENTS

- A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION

SECTION 05 05 19
POST-INSTALLED CONCRETE ANCHORS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Cast-in and drilled in anchors for concrete.
- B. Related Sections:
 - 1. Division 3 Concrete Sections.
 - 2. Division 5 Metals Sections.
 - 3. Division 22 Hangers and Supports Section.
 - 4. Division 23 Hangers and Supports Section.
 - 5. Division 26 Hangers and Supports Section.

1.02 SUBMITTALS

- A. General: Submit in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
 - 1. Product specifications with recommended design values and physical characteristics for epoxy dowels, expansion and undercut anchors.
 - 2. Samples: Representative length and diameters of each type anchor shown on the Drawings.
 - 3. Quality Assurance Submittals:
 - a. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
 - 4. Manufacturer's installation instructions.
 - 5. Installer Qualifications & Procedures: Submit installer qualifications as stated in Section 1.03.B. Submit a letter of procedure stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date, and a list of the personnel to be trained on anchor installation.
- B. Closeout Submittals: Submit the following:
 - 1. Record Documents: Project record documents for installed materials in accordance with Division 1 Closeout Submittals Section.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Drilled-in anchors shall be installed by a contractor with at least three years of experience performing similar installations.
- B. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the contractor on the project. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
 - 1. hole drilling procedure
 - 2. hole preparation & cleaning technique

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3. adhesive injection technique & dispenser training / maintenance
 4. rebar dowel preparation and installation
 5. proof loading/torquing
- 1.04 DELIVERY, STORAGE AND HANDLING
- A. General: Comply with Division 1 Section 27 Product Storage and Handling Requirements.
1. Store anchors in accordance with manufacturer's recommendations.
- PART 2 – PRODUCTS
- 2.01 MATERIALS
- A. Fasteners and Anchors:
1. Bolts and Studs: ASTM A307; ASTM A449 where “high strength” is indicated on the Drawings.
 2. Carbon and Alloy Steel Nuts: ASTM A563.
 3. Carbon Steel Washers: ASTM F436.
 4. Carbon Steel Threaded Rod: ASTM A36; or ASTM A193 Grade B7; or ISO 898 Class 5.8.
 5. Wedge Anchors: ASTM A510; or ASTM A108.
 6. Stainless Steel Bolts, Hex Cap Screws, and Studs: ASTM F593.
 7. Stainless Steel Nuts: ASTM F594.
 8. Zinc Plating: ASTM B633.
 9. Hot-Dip Galvanizing: ASTM A153.
 10. Metric Anchor Bolts, Screws, and Studs: ISO 898 Part 1.
 11. Metric Anchor Nuts: EN 24033.
 12. Metric Anchor Stainless Steel Bolts, Screws, and Studs: ISO 3506 Part 1.
 13. Metric Anchor Stainless Steel Nuts: ISO 3506 Part 2.
 14. Reinforcing Dowels: ASTM A615
- 2.02 CAST-IN-PLACE BOLTS
- A. Anchors, Bolts, Nuts, and Washers: Bolts and studs, nuts, and washers shall conform to ASTM
- B. A307, Grade A, and ASTM A449, ASTM A563, and ASTM F436, as applicable. Hot-dip galvanized bolts and studs including associated nuts and washers in accordance with ASTM A153.
- 2.03 DRILLED-IN ANCHORS
- A. Wedge Anchors: Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers. Provide anchors with length identification markings. Type and size as indicated on Drawings.
1. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).
 2. Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size

tensile strength of the externally threaded fastener. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.

3. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
 - a. Hilti Kwik Bolt 3.
 - b. Hilti Kwik Bolt TZ2 (carbon steel and AISI Type 304 Stainless Steel).
- B. Screw Anchors: screw type. Pre-drilling of the hole requires a standard ANSI drill bit with the same diameter as the anchor and installing the anchor will be done with an impact wrench. Provide anchors with a diameter and anchor length marking on the head. Type and size as indicated on Drawings.
 1. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating equivalent to DIN EN ISO 4042 (82µm min.).
 2. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
 - a. Hilti Kwik-HUS-EZ.
 - b. Hilti Kwik-HUS EZ-I.
 - c. Hilti Kwik-HUS.
- C. Cartridge Injection Adhesive Anchors: Threaded steel rod, inserts or reinforcing dowels, complete with nuts, washers, polymer or hybrid mortar adhesive injection system, and manufacturer's installation instructions. Type and size as indicated on Drawings.
 1. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM A36, ASTM A 193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1) [or carbon steel HIT TZ rods conforming to ASTM A510 with chemical composition of AISI 1038].
 2. Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
 3. Reinforcing dowels shall be A615 Grade 60.
 4. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
 - a. Hilti HAS threaded rods with HIT-HY 200 Safe Set System using Hilti Hollow Drill Bit System for anchorage to concrete.
 - b. Hilti HIT-Z anchor rods with HIT-HY 200 Safe Set System for anchorage to concrete.
 - c. Hilti HAS threaded rods with RE 500 SD Injection Adhesive Anchoring System for anchorage to concrete.
 - d. Hilti HAS threaded rods with RE 500 Injection Adhesive Anchoring System for anchorage to concrete.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Cast-In-Place Bolts: Use templates to locate bolts accurately and securely in formwork.
- B. Drilled-In Anchors:
 - 1. Drill holes with rotary impact hammer drills using carbide-tipped bits, hollow drill bit system, or core drills using diamond core bits. Drill bits shall be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.
 - a. Cored Holes: Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions.
 - b. Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.
 - c. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 2. Perform anchor installation in accordance with manufacturer instructions.
 - 3. Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque shall be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed and replaced unless otherwise directed by the Engineer.
 - 4. Cartridge Injection Adhesive Anchors: Clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into 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. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.
 - 5. Capsule Anchors: Perform drilling and setting operations in accordance with manufacturer instructions. Clean all holes to remove loose material and drilling dust prior to installation of adhesive. Remove water from drilled holes in such a manner as to achieve a surface dry condition. Capsule anchors shall be installed with equipment conforming to manufacturer recommendations. Do not disturb or load anchors before manufacturer specified cure time has elapsed.
 - 6. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

3.02 REPAIR OF DEFECTIVE WORK

- A. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

3.03 FIELD QUALITY CONTROL

- A. Testing: 10% of each type and size of drilled-in anchor shall be proof loaded by the independent testing laboratory. Adhesive anchors and capsule anchors shall not be torque tested unless otherwise directed by the Engineer. If any of the tested anchors fail to achieve the specified torque or proof load within the limits as defined on the Drawings, all anchors of the same diameter and type as the failed anchor shall be tested, unless otherwise instructed by the Engineer.
 - 1. Tension testing should be performed in accordance with ASTM E488.
 - 2. Torque shall be applied with a calibrated torque wrench.
 - 3. Proof loads shall be applied with a calibrated hydraulic ram. Displacement of adhesive and capsule anchors at proof load shall not exceed $D/10$, where D is the nominal anchor diameter.
- B. Minimum anchor embedment, proof loads and torques shall be as shown on the Drawings.

END OF SECTION

SECTION 05 1210
WELDING

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included in This Section:
 - 1. Provisions for the welding of all structural steel members. This includes both field and shop welding.
 - 2. All Welding shall be performed in full accordance with the latest edition of the AWS D1.1-2015 Structural Welding Code-Steel, except as supplemented or modified by this specification. Reiteration or amplification of code provisions as contained in the specification shall not reduce the necessity of compliance with all other code requirements.
 - 3. Shop welding may be by any of the AWS D1.1-2015 approved welding processes except electroslag (ESW) and electrogas (EGW) without specific approval by the engineer.
- B. Related Sections:
 - 1. All pertinent provisions of Division 01 Specification Sections
 - 2. Section 03 20 00: Concrete Reinforcement
 - 3. Section 05 06 50: Welded Stud Connectors
 - 4. Section 05 12 00: Structural Steel Framing
 - 5. Section 05 31 50: Metal Floor and Roof Decking

1.02 REFERENCES

- A. References as specified in Section 05 12 00, "Structural Steel Framing."
- B. Applicable portions of specification section 05 12 00 apply to the work of this section. Contractor shall be responsible to incorporate all applicable portions of specification section 05 12 00 into this section.

1.03 SUBMITTALS

- A. Comply with pertinent provisions of Division 01, Section 01 33 00, "Submittal Procedures."
- B. Welding Procedure specification (WPS):
 - 1. All WPS's shall be submitted to the Structural Engineer of Record (SEOR) for review and approval prior to use.
 - 2. For WPS's that have been qualified by test, the supporting Procedure Qualification Record (PQR) shall be submitted to the Engineer for review and approval. All WPS's and PQR's shall be in accordance with the forms shown in this section.
 - 3. Manufacturer's product data sheets or catalog data for SMAW, FCAW and GMAW composite (cored) filler metals to be used. The data sheets shall describe the product, limitations of use, recommended or typical welding parameters, and storage and exposure requirements, including baking, if applicable.
 - 4. Copies of the manufacturer's typical certificate of conformance for all electrodes, fluxes and shielding gases to be used. Certificates of conformance shall satisfy the applicable

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AWS A5 requirements. For demand critical welds, submit applicable manufacturer's certifications that the filler metal meets the supplemental notch toughness requirements.

5. Included shall be WPS for repair welds.
- C. Submit current valid certificate issued by an independent testing agency for all welders, welding operators, and tack welders.
- D. Submit qualification credentials of all inspectors.
- E. Submit to the Engineer for approval, a step-by-step welding sequence for the field welding of beam-to-column CP-welded and beam-to-beam CP-welded splice connections.
- F. Submit a quality control plan that addresses all inspection issues, including in-process and final inspection that are addressed in AWS D1.1.

1.04

QUALITY ASSURANCE

- A. Comply with all pertinent provisions of Division 01, Section 01 40 00, "Quality Requirements."
- B. Standards:
 1. American Welding Society
 - a. Structural Welding Code (AWS D1.1-2015)
 - b. Structural Welding Code – Seismic Supplement (ASWS D1.8-2009)
 2. American Institute of Steel Construction
 - a. Specification for Structural Steel Buildings (AISC 360-16)
 - b. Code of Standard Practice for Steel Buildings and Bridges (AISC 303-10).
 - c. Seismic Provisions For Structural Steel Buildings including Supplement No. 1 (AISC 341-16), including Appendix W.
- C. Welder Qualification:
 1. All welders, welding operators, and tack welders shall be qualified by test with the largest diameter electrodes to be used on the work and hold a current valid certificate issued by an independent testing agency, to perform the type of welds required by the work; including the process, position, and thickness of materials used per AWS D1.1 section 4.
 2. In addition to meeting the requirements above (section 1.4.B.1), welders that will make welds with restricted access such as, but not limited to, the flange to column welds through a cope hole or access hole in the beam web, or where access to the bottom of a groove is restricted by the presence of a column flange, shall be qualified by the contractor using the same welding procedure as will be used for production and a mock-up assembly that simulates the construction configuration. Qualification test per Annex C of AWS D1.8 is acceptable. Qualifications for welders that have been qualified on previous projects who meet the activity requirements of specification section 05 12 00, section 3.3.B, will be accepted.
 3. All Welders on the project shall be capable of understanding and following the requirements of the written WPS.
 4. Each welder employed on the project shall understand all the requirements of this welding specification before welding on the project.

5. Copies of the Welder Performance Qualification Records (WPQR), including supplemental testing requirements shall be made available for the SEOR and IOR.

PART 2 - PRODUCTS

2.01 WELDING PROCESSES

- A. Weld Procedure Specifications, including Procedure Qualification Records shall be submitted and approved by the SEOR prior to welding. PQRs shall include test results that demonstrate all-weld metal CVN values meet the requirements of Paragraph 2.2A.1 and a minimum tensile strength of 70KSI. CVN and minimum tensile strength conformance of the filler metal may be established by submitting with the PQR the results of heat input envelope testing as per AWS D1.8 section 6.3.8.1.

2.02 MATERIALS

- A. Electrodes:
 1. Filler metals shall conform to the requirements of the latest edition of ANSI/AWS Specifications for Electrodes as listed herein and shall meet Charpy V-Notch Impact Energy of 20 ft-lbs. at 0°F. Filler metals for demand critical welds shall meet Charpy V-Notch Impact Energy of 20 ft-lbs. at -20°F and 40 ft-lbs at 70°F as per AWS D1.8 Section 6.3.5.
 - a. SMAW A5.1 or A5.5 E70XX Low Hydrogen
 - b. SAW A5.17 or A5.23 F7XX-EXXX or F7XX-EXXX-XX
 - c. GMAW A5.18 or A5.28 ER70S-X
 - d. FCAW A5.20 or A5.29 E7XT-X except T8-K6
 - e. The Charpy V-Notch requirement above does not apply to welds used in the construction of stairs, elevator guiderail supports, steel supports for partitions or exterior walls, steel supports for exterior architectural appendages, steel supports for MEP equipment, rooftop screen walls, and light gage metal stud framing.
 2. The use of E70-T4 Electrode is not allowed for any welding application.
 3. The manufacturer shall certify that consumables used in the Work conform with AWS D1.8 Section 6.3.

PART 3 - EXECUTION

3.01 WELDING PROCEDURE SPECIFICATION (WPS)

- A. All welding shall be performed in strict adherence to a written WPS, whether the WPS be pre-qualified or qualified by test. Electrodes shall be limited to the diameters listed herein and welding shall preferably use a stringer bead technique. If weave beads are used, they shall be limited to the following diameter widths:
 1. SMAW – Maximum diameter (d) 3/16 inch and maximum widths shall be:
 - a. 4d for 3/32 inch electrodes
 - b. 3d for 1/8 inch electrodes
 - c. 2 ½ d for 5/32 inch electrodes
 - d. 2 d for 3/16 inch electrodes limited to flat and horizontal positions
 - e. These weave widths shall be strictly adhered to except final (cover) pass(s) may be a maximum of 5/8 inches.

- B. All WPS's shall be prepared by qualified individuals and the same individual responsible for the suitability of the WPS.
- C. The written WPS shall be available to the welder, welding supervisor, and inspector.
- D. All welding equipment shall be properly maintained. Current/amperage and voltage shall be tested for compliance to WPS required ranges by calibrated instruments and also such gauges on the equipment shall be checked for manufacturers stated accuracy.
- E. WPS's for SMAW, SAW and FCAW-G may be pre-qualified providing they meet all the requirements of AWS D1.1-2015, paragraph 3.2.1. Any deviation from the pre-qualified WPS requirements shall necessitate qualifications by test.
- F. WPS's that are not pre-qualified shall be subject to the qualification testing specified in AWS D1.1-2015, section 4. For WPS's that have not been qualified by test, the supporting procedure qualification record (PQR) shall be submitted with the WPS for approval by the Engineer.
- G. The written WPS shall contain all the necessary information required by the code, this specification, and any other information necessary to produce the welds that are in compliance with these requirements.
- H. The WPS shall list the applicable base metal types and thicknesses.
- I. The WPS shall contain a sketch of the joint and shall list the welding joint details, including type, weld type, joint geometry, and applicable dimensions. Individual weld passes shall be identified in the sketch and numbered to identify the maximum layer thickness and bead widths. Layer thickness shall conform to AWS D1.1 table 3.7 or as qualified by the PQR.
- J. The WPS shall list the applicable welding processes.
- K. The WPS shall indicate the minimum preheat requirements. The preheat and inter-pass temperatures shall be determined in accordance with AWS D1.1 Table 3.2. Maximum inter-pass temperature shall be 550°F.
- L. The WPS shall list all applicable electrical characteristics for the process employed and shall include, as a reference, the electrode manufacturer's cutsheet. The product data sheets or catalog data for SMAW FCAW and the WPS shall clearly indicate the acceptable values required for each welding pass. These electrical characteristics shall include at a minimum the following:
 - 1. Type of current, and acceptable ranges of current measures in amperage. For wire feed process both wire feed and amperage should be listed.
 - 2. Voltage
 - 3. Travel speed (range)
 - 4. Electrode extension for wire feed processes
 - 5. Amperage, voltage and electrode extension (as applicable) shall be within the filler metal manufacturer's recommendation
- M. The diameter of the electrodes specified on the WPS shall not exceed the limits listed in section 3.1.A. of this specification section.

3.02 FABRICATION AND ERECTION

- A. Assembly:
 - 1. Assembly shall not exceed those for pre-qualified joint detail employed, or the limits of AWS D1.1-2015, Figures 5.3 and 5.4, as applicable. The minimum root opening dimension shall

be maintained for the length of the joint. For joints where the minimum root opening dimension is less than the minimum requirement, compensation may be made by increasing the root opening by gouging, chipping or grinding. At the contractor's option, or alternate approved written WPS suitable for the smaller root opening may be employed. Root openings that exceed the maximum allowable may be corrected by welding to acceptable dimensions prior to joining the parts by welding. The Engineer shall be notified when the root opening exceeds the allowable tolerance range.

- B. Tack Welds: All tack welds shall be of the same quality as the final welds. This includes the requirements for preheat except as noted in AWS D1.1 section 5.18.5.
- C. Weld Access Holes: Weld Access holes shall be sized to ensure adequate access for the welding process being used. Minimum sizes shall be in accordance with AWS D1.1-2015, 5.17 and Figure 5.2
- D. Weld Termination:
 - 1. Weld tabs shall be employed as shown in the Structural Drawing. Minimum length shall be the thickness of groove joint or 1 inch, whichever is greater, but not exceed 2 inches as per AWS D1.8 section 6.11.1.
 - 2. End dams shall not be allowed.
 - 3. Weld tabs shall be removed in accordance with AWS D1.8 section 6.10.
- E. Steel Backing: Remove steel backing where so indicated on drawings. If backing bars are removed, the removal area shall be tested for defects or a reinforcing fillet weld, at least $\frac{1}{4}$ of the flange thickness, but not greater than $\frac{3}{8}$ inch, shall be applied.
- F. Preheating: To ensure the work place is properly heated, the temperature of the part shall be measured at a distance from the axis of the weld equal to twice the thickness of the thickest part being welded, but in no case less than 3 inches in all directions, including the through thickness dimension of the part being welded, for the full length of the weld joint. Preheat shall be verified by the inspector before welding commences.
- G. Peening: Peening shall not be allowed except if approved by the SEOR.
- H. Technique for making Welds involving Weld Access Holes:
 - 1. After the joint is assembled (bolts not fully torqued), the weld shall be completed as follows:
 - a. The root pass shall initiate near the center of the joint, in the area of the weld access hole. The welder shall extend the electrode through the weld access hole approximately 1" beyond the opposite side of the web. After the arc is initiated, travel shall progress toward the end of the joint, and the weld shall be terminated on the weld tab.
 - b. The half-length of root pass shall be thoroughly cleaned.
 - c. The start of the weld in the weld access hole area shall be visually inspected to ensure fusion, soundness, freedom from slag inclusions, and excessive porosity, the resulting lead profile shall be suitable for obtaining good fusion by the subsequent pass to be initiated on the opposite side of the beam web. If the profile is not conducive to good fusion, the start of the first root pass shall be ground, gouged, chipped or otherwise prepared to ensure adequate fusion.
 - d. The second half of the weld joint shall have the root pass applied before any other weld passes are performed. The arc shall be initiated in the area of the

start of the first root pass, and travel shall progress to the end of the joint, terminating on the weld tab.

- e. Each new layer shall be completed on both sides of the joint before a new layer is deposited.
- f. Deviation from the preceding procedure may be made, providing the contractor submits in writing an alternate sequence that is approved by the Engineer prior to fabrication.

3.03 QUALITY CONTROL AND QUALITY ASSURANCE

- A. Where there is a conflict with the above specifications and the drawings, the more stringent of the two shall prevail.
- B. Comply with pertinent provisions of Division 01 Section 01 40 00 "Quality Requirements."
- C. Inspection provided by the Owner:
 - 1. Qualifications: All inspectors shall meet the requirements of AWS D1.1, section 6.1.4 and hold current Certified Welding Inspector (CWI) certification.
 - 2. Inspection Agency Responsibility: The inspection agency shall perform all required inspection including the requirements herein. The inspector(s) shall be present before during and after welding on all Complete Joint Penetration (CJP) weld and as necessary during all other welding operations. The inspector(s) shall also be present during removal of steel backing and run off tabs.
 - 3. All full penetration groove welds shall be ultrasonic testing, as per AWS D1.1, Section 6 "Inspection, Part "F", Ultrasonic Testing of Groove Welds". All defective welds shall be repaired and retested with ultrasonic equipment at the Contractor's expense.
 - 4. Flanges: An area extending 6" above and below point of attachment for CJP welds and flange edge shall be inspected visually, and the entire area ultrasonically for lamination, plate discontinuities and non-metallic inclusions.
 - 5. Ultrasonic inspections of all CJP welds shall be conducted from both the top and bottom sides of the flange, and from the back side of the column flange as necessary to determine potential rejectable welding defects.
 - 6. All weld tabs shall be removed. The affected area shall be ground smooth and magnetic particle tested for defects. Dye penetrant may be used where required.
 - 7. Where backup bars are required to be removed, the weld root area shall be magnetic particle tested for defects.
 - 8. Base metal thicker than 1½ inches, when subjected to through thickness weld shrinkage strains, shall be ultrasonically inspected for discontinuities directly behind such weld before and after joint completion. Repairs if needed, to parent material shall comply with ASTM A6 Sec.9.
 - 9. All Non-Destructive Testing (NDT) shall be performed after all welds are complete including, but not limited to, removal of steel backing and grinding of same, removal of reinforcement as per AWS D1.1 section 5.24.4, 5.24.4.1 and 5.24.4.2; any postweld heat treatment. This is not intended to exclude in-house intermittent NDT programs.
 - 10. All NDT except UT shall not be started before a minimum of 24 hours after subject weldments have cooled to ambient temperature.

11. NDT personnel, other than UT, shall also submit their experience and qualification on like type weldments when required by the Engineer.

WELDING PROCEDURE SPECIFICATION (WPS)

PREQUALIFIED ☐ QUALIFIED BY TESTING ☐ Yes ☐

Or PROCEDURE QUALIFICATION RECORDS (PQR) Yes ☐

Company Name _____
 Welding Process _____
 Supporting PQR No. (s) _____

Identification # _____
 Revision _____ Date _____ By _____
 Authorized by _____
 Type: Manual ☐ Semi-Automatic ☐
 Machine ☐ Automatic ☐

JOINT DESIGN USED
 Type: _____ Single ☐ Double Weld ☐
 Backing: Yes ☐ No ☐
 Backing Material _____
 Root Opening _____ Root Face Dim. _____
 Groove Angle _____ Radius (J-U) _____
 Back Gouging Y ☐ N ☐ Method _____

POSITION
 Position of Groove _____
 Vertical Progression: Fillet: _____
 Up ☐ Down ☐

ELECTRICAL CHARACTERISTICS
 Transfer Mode (GMAW) Short Circuiting ☐ Spray ☐
 Globular ☐

Current: AC ☐ DCEP ☐ DCEN ☐ Pulsed ☐

BASE METALS
 Material Spec. _____
 Type or Grade _____
 Thickness _____ Groove _____ Fillet _____
 Diameter (Pipe) _____

Other _____
 Tungsten Electrode (GTAW): Size _____
 Type _____

TECHNIQUE
 Stringer or Weave Bead _____
 Multi-pass or Single Pass (per _____
 side)

FILLER METALS
 AWR Specification _____
 AWS Classification _____
 MNFR ID _____

Number of Electrodes _____
 Electrode Spacing: Longitudinal _____
 Lateral _____
 Angles _____

SHIELDING
 Flux _____ Gas _____
 Composition _____

Contact Tube to Work Distance _____
 Peening _____
 Interpass Cleaning _____

Electrode-Flux (Class) _____ Flow Rate _____
 Gas Cup Size _____

POSTWELD HEAT TREATMENT
 Temp. _____
 Time _____

PREHEAT
 Preheat Temp. Min. _____
 Interpass Temp. Min. _____ Max _____

WELDING PROCEDURE

Pass or Weld Layer (s)	Process	Filler Metals		Current		Volts	Travel Speed	Joint Details
		Class	Diam.	Type & Polarity	Amps or Wire Feed Speed			

PROCEDURE QUALIFICATION RECORD

Fabricator	Test Date
Process	Filler Metal
Position	
Electrode(s) Mfg. Designation	
Flux Mfg. Designation	
Electrode Extension	

	Diam.	Current	WFS	Voltage	Current & Polarity
Electrode (1)					
(2)					
(3)					

Calculated Heat Input (see 5.2.4)	
Shielding Gas	Flow Rate
Dew Point	Travel Speed
Base Metal Specification & Thickness	
(attach certified copy of mill test report)	

Preheat Temp.	Interpass Temp. Minimum	Maximum

SPECIMEN	TEST RESULTS
A Weld Metal Tension (AWMT)	Tensile Strength (psi)
	Yield Strength (psi)
	Elongation in 2 in. (%)
	Reduction in area (%)

Side Bends	1)	2)	3)	4)

Reduced Section Tension	Tensile Strength 1)	Location of Break 1)
	2)	2)

Charpy V-Notch Impact			
Toughness of Weld Metal	Avg. Ft. lb.	@	Degrees F.

SMAW, SAW, FCAW, GMAW – 5 Reg.			
Toughness of Weld Metal	Avg. Ft. lb.	@	Degrees F.

Chemistry of Deposited Weld Metal	C	Mn	Si	P	S
When Required by Contract Documents	Ni	Cr	Mo	V	Cu

REMARKS	Visual
	Radiographic Test

Wire feed may be used in lieu of current when a correlation curve for the same electrode diameter and same electrode extension.

Test Witness:	Agency:
Results Reviewed:	State Acceptance: Date:

END OF SECTION

SECTION 07 6000
FLASHING AND SHEET METAL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Miscellaneous metal flashing and counter flashing as required, except where provided under Divisions 22, Plumbing, 23, HVAC, or 26, Electrical.
2. Other sheet metal items, not necessarily specified herein or in other sections, but required to prevent penetration of water into building.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 07 9200 - Joint Sealants.
3. Division 26 - Electrical.

1.02 SUBMITTALS

- A. Shop Drawings:** Submit for fabricated sheet metal indicating shapes, details, methods of joining, anchoring and fastening, thicknesses and gages of metals, concealed reinforcement, expansion joint details, sections, profiles and finishes.
- B. Samples:** Submit Samples for materials or assemblies as requested.
- C. Product Data:** Submit brochures of manufactured items.

1.03 QUALITY ASSURANCE

- A. Drawings and requirements specified govern. Provide the Work of this section in conformance with the Architectural Sheet Metal Manual published by SMACNA for conditions not indicated or specified and for general fabrication of sheet metal items.**
- B. Materials shall conform to following standards:**
1. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 2. ASTM A653 - Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 3. ASTM B370 - Copper Sheet and Strip for Building Construction.
- C. Pre-installation Meetings:** Refer to Division 07 roofing sections as appropriate. Attend the pre-installation and inspection meetings for roofing Work.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Do not install bent or otherwise damaged materials.**

PART 2 - PRODUCTS

Flashing and Sheet Metal
07 6000-1

2.01 MATERIALS

- A. Galvanized Sheet Steel: ASTM A653, coating designation G90, hot-dip galvanized.
- B. Stainless Steel: Plate, sheet and strip shall conform to ASTM A167, Type 304 or Type 316, No. 4 finish on exposed surfaces and No. 2 finish on concealed surfaces unless otherwise specified or indicated. Furnish Type 304 for general applications and Type 316 where exposed to acidic or alkaline conditions.
- C. Fastenings:
 - 1. Galvanized Steel: Nails, rivets, and other fastenings furnished in connection with galvanized sheet steel Work shall be sealed with rust resistive coating. Rivets shall be tinned. Nails and other fastenings shall be zinc-coated.
 - 2. Stainless Steel: Nails, rivets and other fastenings furnished in connection with stainless steel Work, shall be 300 series alloy to match alloy of stainless steel being fastened.
- D. Soldering Flux: Raw muriatic acid for galvanized steel; rosin for tin, lead and tinned copper; non-corrosive soldering salts for uncoated copper and acid-type flux formulated for soldering stainless steel.
- E. Solder: ASTM B32, Grade 5A, composed of 95-5 tin-antimony. Name of product manufacturer and grade designation shall be labeled, stamped or cast onto each coil or bar.

2.02 FABRICATION

- A. General:
 - 1. Accurately form sheet metal Work to dimensions and shapes indicated and required. Cope finish molded and brake metal shapes with true, straight, sharp lines and angles and, where intersecting each other, to a precise fit. Unless otherwise specified, all galvanized sheet steel shall be 22 gage. Exposed edges of sheet metal shall have a ½ inch minimum hemmed edge.
 - 2. Soldering of sheet steel or copper shall be performed with well-heated copper soldering iron or soldering torch, joints full flowing, neat and consistent. Fill joint completely with solder. Clean materials at joints before soldering, and tin coppers before soldering. Exposed soldering on finished surfaces shall be scraped smooth. Lock seam work shall be fabricated flat and true to line and soldered along its entire length. Acid-fluxed Work shall be neutralized after fabrication.
 - 3. Form and install sheet metal Work to provide proper allowances for expansion and contraction, without causing undue stresses in any part of completed Work. Installation shall be water and weathertight.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Concrete and masonry materials in contact with sheet metal shall be painted with alkali resistant coating, such as heavy-bodied bituminous paint. Wood in contact with sheet metal shall be painted with two coats of aluminum paint or one coat of heavy-bodied bituminous paint.

3.02 INSTALLATION

- A. General: Coordinate with installation of underlayment indicated in the Drawings.

3.03 TESTING

- A. Perform field water testing to demonstrate installation is watertight. Continue testing with a continuous hose stream applied at base of installation for at least 30 minutes. If leaking is observed, discontinue test and repair installation, then test until satisfactory results are obtained.

3.04 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.05 CLEANING

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 07 9200 JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Joint sealants.
 - 2. Preparation for application of sealants.
- B. Related Requirements:
 - 1. Division 01 - General Requirements.
 - 2. Section 07 6000 - Flashing and Sheet Metal.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings indicating sealant joint locations, with full-size sealant joint details.
- B. Product Data: Submit manufacturer's literature for each sealant material.
- C. Material Samples: Submit Samples indicating color range available for each sealant material intended for installation in exposed locations.
- D. Certifications: Submit manufacturer's certification materials comply with requirements specified.

1.03 QUALITY ASSURANCE

- A. Qualifications of Installer: The Work of this section shall be installed by a firm which has been in the business of installing similar materials for at least five consecutive years; and can show evidence of satisfactory completion of five projects of similar size and scope. Installer shall have applicators trained and approved by manufacturer for performing this Work.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Store in accordance with manufacturer's recommendations. Provide a uniform ambient temperature between 60 and 80 degrees F.

1.05 WARRANTY

- A. Manufacturer: five year material warranty.
- B. Installer: two year installation/application warranty.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Furnish sealants meeting following in-service requirements:
 - 1. Normal curing schedules are permitted.
 - 2. Non-staining, color fastness (resistance to color change), and durability when subjected to intense actinic (ultraviolet) radiation are required.
- B. Furnish the products of only one manufacturer unless otherwise required, sealant colors as selected to match the adjoining surfaces.

2.02 MATERIALS

- A. Sealants:
 - 1. Sealant 1: Acrylic latex, one-part, non-sag, mildew resistant acrylic emulsion compound complying with ASTM C834, Type S, Grade NS, formulated to be paintable.
 - a. Tremco Inc., Acrylic Latex Caulk.
 - b. Pecora Corporation, AC-20.
 - c. Equal.
 - 2. Sealant 2: Butyl sealant, one-part, non-sag, solvent-release-curing sealant complying with ASTM C1311, gun grade and formulated with a minimum of 75 percent solids.
 - a. Tremco Inc., Tremco Butyl Sealant.
 - b. Pecora Corp., BC-158.
 - c. Equal.
 - 3. Sealant 3: Silicone sealant, one-part non-acid-curing silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25.
 - a. Dow Corning Corp., Dow Corning 790, 791, 795.
 - b. General Electric Co., Silpruf.
 - c. Tremco, Inc., Spectrem 1.
 - d. Pecora Corp., 864.
 - e. Equal.
 - 4. Sealant 4: One-part mildew-resistant silicone sealant, complying with ASTM C920, Type S, Grade NS, Class 25.
 - a. Dow Corning Corp., Dow Corning 786.
 - b. General Electric Co., Sanitary 1700.

- c. Tremco, Inc., Proglaze White.
 - d. Equal.
 - 5. Sealant 5: One-part non-sag urethane sealant, complying with ASTM C920, Type S, Grade NS, Class 25.
 - a. Sika Corporation, Sikaflex -221e.
 - b. Equal.
 - 6. Sealant 6: Multi-part pouring urethane sealant, complying with ASTM C920, Type M, Grade P, Class 25.
 - a. Sika Corporation, Sikaflex 2C NS/SL.
 - b. Equal.
 - 7. Sealant 7: Acoustical sealant, non-drying, non-hardening permanently flexible conforming to ASTM D217.
 - a. Pecora Corp., BA-98 Acoustical Sealant.
 - b. Equal.
- B. Joint Backing: ASTM D1056; round, closed cell Polyethylene Foam Rod; oversized 30 to 50 percent larger than joint width, reticulated polyolefin foam.
- C. Primer: Non-Staining Type. Provide primer as required and shall be product of manufacturer of installed sealant.
- D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer.
- E. Sealants shall have normal curing schedules, shall be nonstaining, color fast and shall resist deterioration due to ultraviolet radiation.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that joint openings are ready to receive Work and field tolerances are within the guidelines recommended by sealant manufacturer.

3.02 SURFACE PREPARATION

- A. Joints and spaces to be sealed shall be completely cleaned of all dirt, dust, mortar, oil, and other foreign materials which might adversely affect sealing Work. Where necessary, degrease with a solvent or commercial degreasing agent. Surfaces shall be thoroughly dry before application of sealants.
- B. If recommended by manufacturer, remove paint and other protective coatings from surfaces to be sealed before priming and installation of sealants.

- C. Preparation of surfaces to receive sealant shall conform to the sealant manufacturer's specifications. Provide air pressure or other methods to achieve required results. Provide masking tape to keep sealants off surfaces that will be exposed in finished Work.
- D. Etch concrete or masonry surfaces to remove excess alkalinity, unless sealant manufacturer's printed instructions indicate that alkalinity does not interfere with sealant bond and performance. Etch with 5 percent solution of muriatic acid; neutralize with dilute ammonia solution, rinse thoroughly with water and allow to dry before sealant installation.
- E. Perform preparation in accordance with ASTM C804 for solvent release sealants, and ASTM C962 for elastomeric sealants.
- F. Protect elements surrounding Work of this section from damage or disfiguration.

3.03 SEALANT APPLICATION SCHEDULE

	Location	Type	Color
A	Exterior and Interior joints in horizontal surfaces of concrete; between metal and concrete masonry and mortar.	Sealant 6	Match Adjacent Material
B	Exterior door, entrance and window frames. Exterior and interior vertical joints in concrete and masonry metal flashing.	Sealant 3 or 5	Match Adjacent Material
C	Joints within glazed curtain wall system. Skylight framing system. Aluminum entrance system glass and glazing.	Sealant 3	Translucent or Black
D	Interior joints in ceramic tile and at plumbing fixtures.	Sealant 4	Translucent or White
E	Under thresholds.	Sealant 2	Black
F	All interior joints not otherwise scheduled	Sealant 1	Match Adjacent Surfaces
G	Heads and sills, perimeters of frames and other openings in insulated partitions.	Sealant 7	Match Adjacent Surfaces

3.04 APPLICATION

- A. Provide sealant around all openings in exterior walls, and any other locations indicated or required for structure weatherproofing and/or waterproofing.
- B. Sealants shall be installed by experienced mechanics using specified materials and proper tools. Preparatory Work (cleaning, etc.) and installation of sealant shall be as specified and in accordance with manufacturer's printed instructions and recommendations.
- C. Concrete, masonry, and other porous surfaces, and any other surfaces if recommended by manufacturer, shall be primed before installing sealants. Primer shall be installed with a brush that will reach all parts of joints to be filled with sealant.
- D. Sealants shall be stored and installed at temperatures as recommended by manufacturer. Sealants shall not be installed when they become too jelled to be discharged in a continuous flow from gun. Modification of sealants by addition of liquids, solvents, or powders is not permitted.
- E. Sealants shall be installed with guns furnished with proper size nozzles. Sufficient pressure shall be furnished to fill all voids and joints solid. In sealing around openings, include entire perimeter of each opening, unless indicated or specified otherwise. Where gun installation is impracticable, suitable hand tools shall be provided.
- F. Sealed joints shall be neatly pointed on flush surfaces with beading tool, and internal corners with a special tool. Excess material shall be cleanly removed. Sealant, where exposed, shall be free of wrinkles and uniformly smooth. Sealing shall be complete before final coats of paint are installed.
- G. Comply with sealant manufacturer's printed instructions except where more stringent requirements are indicated on Drawings or specified.
- H. Partially fill joints with joint backing material, furnishing only compatible materials, until joint depth does not exceed 1/2 inch joint width. Minimum joint width for metal to metal joints shall be 1/4 inch. Joint depth, shall be not less than 1/4 inch and not greater than 1/2 inch.
- I. Install sealant under sufficient pressure to completely fill voids. Finish exposed joints smooth, flush with surfaces or recessed as indicated. Install non-tracking sealant to concrete expansion joints subject to foot or vehicular traffic.
- J. Where joint depth prevents installation of standard bond breaker backing rod, furnish non-adhering tape covering to prevent bonding of sealant to back of joint. Under no circumstances shall sealant depth exceed 1/2 inch maximum, unless specifically indicated on Drawings.

- K. Prime porous surfaces after cleaning. Pack joints deeper than 3/4 inch with joint backing to within 3/4 inch of surface. Completely fill joints and spaces with gun applied compound, forming a neat, smooth bead.

3.05 MISCELLANEOUS WORK

- A. Sealing shall be provided wherever required to prevent light leakage as well as moisture leakage. Refer to Drawings for condition and related parts of Work.
- B. Install sealants to depths as indicated or, if not indicated, as recommended by sealant manufacturer but within following general limitations:
 - 1. For joints in concrete walks, slab and paving subject to traffic, fill joints to a depth equal to 75 percent of joint width, but not more than 3/4 inch deep or less than 3/8 inch deep, depending on joint width.
 - 2. For building joints, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2 inch deep or less than 1/4 inch deep.

3.06 CLEANING

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.07 CURING

- A. Sealants shall cure in accordance with manufacturer's printed recommendations. Do not disturb seal until completely cured.

3.08 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION

**SECTION 08 1113
HOLLOW METAL DOORS AND FRAMES**

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Hollow metal doors and frames or hollow metal doors as indicated.
2. Hollow metal window frames or hollow metal door and window frames.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 07 9200 - Joint Sealants.
3. Section 08 1416 - Flush Wood Doors.
4. Section 08 7100 - Door Hardware.
5. Section 09 9000 - Painting and Coating.

1.02 DESIGN REQUIREMENTS

- A.** Door-and-frame assemblies or frames shall include reinforcing and provisions for hardware as shown and specified. Drawings indicate profile and general details of steel frame fabrication and installation.

1.03 SUBMITTALS

- A.** Shop Drawings: Submit composite Shop Drawings indicating detailed relationships of installation including Work of adjacent construction, finish hardware, security, fire and life safety devices, glazing, sealing, and requirements for field installation. Include elevations of each hollow metal door type, details of each frame type, location schedule of doors and frames indicating same reference for details and openings as indicated on Drawings, conditions of openings of various wall sections and materials, typical and special details of construction, methods of assembling sections, location and installation requirements for hardware, material size, shape, and thickness, and joints and connections.
- B.** Product Data: Submit manufacturer's Product Data indicating composition and construction for each fabricated item including louvers, coatings, finishes, and other components demonstrating compliance with referenced standards.
- C.** Certification: Submit certification of compliance with referenced standards and specified criteria, including but not limited to fire ratings in accordance with UL 10C,

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Physical Endurance in accordance with ANSI A250.4 and Prime Paint performance in accordance with ANSI A250.10..

D. Samples:

1. Hollow Metal Frame: Corner section of typical exterior and interior frame, of sufficient composite size to illustrate corner joint construction, hinge reinforcement, closer re-enforcement, floor anchor, dust cover, and jamb anchors, and showing galvanizing and prime coat finishes.
2. Hollow Metal Door: Section of typical interior door of sufficient composite size to illustrate edge, top, bottom, and core construction, hinge reinforcement and face stiffening, closer reinforcement and kick plate reinforcement, and corner of vision opening construction with glazing beads.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum documented experience of more than five years in work of this section.
- B. Installer Qualifications: Minimum documented experience of more than five years in work of this section
- C. Coordinate with hardware supplier for fabrication of doors and frames to receive hardware items.
- D. Coordinate with intrusion alarm supplier for fabrication of doors and frames to receive intrusion detection devices.
- E. References: Work shall comply with physical and performance requirements of following standards, including standards referenced in them, except for more stringent provisions specified herein or required by regulatory agencies:
 1. ANSI/SDI A250.8, SDI 100 Recommended Specifications for Standard Steel Doors and Frames.
 2. ANSI/NFPA 252, Fire Tests of Door Assemblies.
 3. ANSI/UL 10B, Fire Tests of Door Assemblies.
 4. ANSI/UL 10C, Positive-Pressure Fire Tests of Door Assemblies.
 5. ANSI/NFPA 80, Fire Doors and Fire Windows
 6. HMMA, Guide Specifications for Commercial Hollow Metal Doors & Frames (Standard of National Association of Architectural Metal Manufacturers).
 7. ANSI/SDI A250.4, Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frame Anchors and Hardware Reinforcings.

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8. ANSI A250.10, Test Procedure and Acceptance Criteria for Prime Painted Steel Doors and Frames.
9. ANSI A250.6, Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.

F. Standards of Fabrication and Installation:

1. Finished Work shall be of uniform profile, accurately fabricated, rigid and strong, square and true, neat in appearance, smooth and free from dents, waves, warps, buckles, open joints, tool marks and/or other defects.
2. Steel sheet shall be clean with smooth surfaces free of scale, pitting or other defects.
3. Construction joints shall be flush, tight and welded their full length, ground flush and smooth on exposed surfaces.
4. Frame and door reinforcing and hardware provisions shall be performed in fabrication shop. Provide cuts, welds, and other fabrications before galvanizing or shop priming.
5. Lines and molded members shall be straight and true with angles as sharp as practical for thickness involved, surfaces flat, and fastenings concealed.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Frames: Before shipment, install temporary spreaders at bottom of bucks and do not remove until frames are installed.
- B. Doors: Provide protection as required to protect doors during shipping and storage. Damaged doors will be rejected.
- C. Inspect hollow metal Work upon delivery for damage. Remove and replace damaged items with new Work as required.
- D. Store doors and frames in an upright position at Project Site under cover and protected from weather-related elements. Store units on minimum 4-inch high wood blocking with ½ inch air spaces between stacked doors to provide circulation. Do not store doors and frames under plastic or canvas shelters that can create a humidity chamber. If shipping packaging becomes wet, immediately remove packaging.

1.06 WARRANTY

- A. Manufacturer shall provide a five year material warranty.
- B. Installer shall provide a two year fabrication and installation warranty.

PART 2 - PRODUCTS

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08 1113-3

2.01 MANUFACTURERS

- A. Doors and frames shall be products of a single manufacturer.
- B. The following are acceptable manufacturers, as are others that can demonstrate their products are equivalent in quality, performance and compliance with these specifications.
 - 1. Security Metal Products Corp.
 - 2. Curries Manufacturing, Inc.
 - 3. Steelcraft.
 - 4. Amweld Metal Doors and Frames.
 - 5. Stiles Custom Metal, Inc.
 - 6. Door Components Inc.
 - 7. CECO Door.
 - 8. Equal.
- C. Materials, fabrication and installation must comply with requirements of standards referenced in Section 1.04, Quality Assurance.

2.02 MATERIALS

- A. Steel:
 - 1. Exterior Doors and Frames: Galvanized Carbon Sheet Steel, Commercial Quality, A60 zinc coating (0.30 ounces per square foot per side), ASTM A653.
 - 2. Interior Doors and Frames: Cold-Rolled Steel Sheets, Commercial Quality Carbon Steel, ASTM A1008.
 - 3. Steel shall be free of scale, pitting, coil breaks or other surface blemishes, and free of buckles, waves or other defects.
 - 4. Steel thicknesses expressed in steel gages (MSG) is for reference only. Actual steel thicknesses must meet minimum requirements of ASTM standards and as described in ANSI/SDI A250.8.
- B. Supports and Anchors: Fabricate from a minimum 16 gauge galvanized sheet steel unless noted otherwise.
- C. Fasteners: Provide as shown on Drawings and to suit conditions of secure installations. Furnish 304 Grade stainless steel types at exterior doors.

Metal Doors and Frames
08 1113-4

D. Door Louvers:

1. Louver free air flow shall be 50% free area.
2. Louvers for exterior doors shall be galvanized and furnished with not less than 12 gage frame and security grille welded to 18 gage steel blades, fully galvanized, with removable galvanized or bronze insect screen on inside. Install louver with tamperproof-head through-bolts. Anemostat PLSL, Air Louvers Inc. Model 1500-A, L & L Louvers, or equal.
3. Fusible link louvers: Listed by State Fire Marshal, UL labeled and installed with tamperproof fasteners.
4. Lightproof louvers (at dark rooms): DRDL by Anemostat, Air Louver Model 1000, L & L Louvers, or equal.
5. Louvers shall be comply with SDI 111C and be furnished with factory primer.

E. Vision panels: Manufacturer's standard, U.L. approved, finished flush with door face, with no visible fasteners on either door face.

F. Shop Paint:

1. Conform to Steel Structures Painting Council (SSPC) for steel components.
2. Pretreatment/priming coatings shall be compatible with Project site finish painting system in accordance with Section 09 9000.
3. At frames to be grouted, surfaces that are inaccessible after installation shall be coated with bituminous or asphaltic base paint.

2.03 FABRICATION GENERAL

A. General: Fabricate hollow metal units to be rigid, neat in appearance, and free from defects including warp or buckle.

1. Accurately form metal to required sizes and profiles. Fit and assemble units in manufacturer's plant. Where practical, factory or shop fit and assemble units for shipment.
2. Weld joints continuously; grind, dress, and make smooth, flush, and invisible. Filler to conceal manufacturing defects or damage is not permitted.
3. Corner Joints: Finish corner joints by mitering, or coping and butting, or a combination of both. Trim and backbend shall be continuous around corner.
4. Continuously weld joints for full depth and width of frame, trim, and backbends.
5. Clearances for Fire-Rated Doors: As required by NFPA 80.

2.04 FRAMES

- A. General: Provide fully welded steel frames with integral stops and trim for doors, transoms, sidelights, borrowed lights, and other openings, and with details indicated for type and profile. Use concealed fastenings, unless otherwise indicated.
- B. Metal Thickness of Frames (minimum):
 - 1. Interior hollow metal frames up to 4-foot wide 16 gage
 - 2. Interior hollow metal frames wider than 4-foot 14 gage
 - 3. Exterior hollow metal frames 14 gage
 - 4. Borrowed lights up to 4-foot wide 16 gage
- C. Supports and Anchors: Fabricate from at least 16-gage, galvanized steel sheet. Frame anchors shall comply with fire rated label requirements of opening.
 - 1. Floor Anchors:
 - a. Minimum thickness: 12 gage galvanized steel sheet or bent steel plate, securely fastened inside each jamb, with two holes in anchor at each jamb for 3/8 inch floor anchorage fasteners. For preframed wood stud walls provide an additional wood stud anchor located as close to the bottom of the jamb as is practical.
 - b. Where required at sloping and uneven floor conditions, or to coordinate adjustments for trim alignments, provide adjustable floor anchors, providing at least 2-inch height adjustments.
 - 2. Jamb Anchors:
 - a. Locate anchors near top and bottom and at intermediate points not to exceed 24 inches on center. Provide two anchors per head for openings up to 48 inches wide; over 48 inches wide provide anchors at 24 inches on center maximum.
 - b. Anchors in masonry construction: Provide manufacturers standard jamb anchors. Steel wire complying with ASTM A510, 0.177 inch in diameter, may be furnished.
 - c. Anchors in Stud Partitions: Provide steel anchors, 16 gage minimum sheet steel, of design to suit partition construction, securely welded inside each jamb.
 - d. Through-Frame Anchors: At frames indicated to be anchored with bolts through frame, provide countersunk holes for bolts with 16 gauge minimum sheet steel stiffeners full thickness of frame, and securely welded inside each frame at each hole.

- D. Inserts, Bolts, and Fasteners: Provide manufacturer's standard units. Where zinc-coated items are to be built into exterior walls, comply with ASTM A153 Class C or D as required.
- E. Head Reinforcing: Refer to Detail #2 of this section. Reinforcing shall not act as lintel or load-carrying member and shall comply with fire rating requirements. Provide at frames regardless of whether a closer is called for.
- F. Hardware Reinforcement and Accessories:
 - 1. Butt Hinge: 7 gage minimum.
 - 2. Continuous hinge: 14 gage continuous strip reinforcing.
 - 3. Head assemblies: Reinforced internally with, full length, 10 gage angles on each side of frame and bar at bottom of stop for closer reinforcement in frames as shown in Detail #2 of this section.
 - 4. Reinforcing for other items of finish hardware shall be accomplished according to ANSI A250.6.
 - 5. Plaster Guards: Provide 26 gage galvanized steel plaster guards or dust cover boxes, welded to frame, at back of finish hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.
- G. Mullion and Transom bars: Furnished and fabricated as specified for frames.
- H. Glazed Openings: Applied stops with mitered or butted corners, of minimum 18 gage galvanized steel, one-piece lengths, secured within 3" of ends and at 12" centers with oval head countersunk tamper resistant screws. Corner joints shall be furnished with contact edges closed tight, with trim faces mitered and continuously welded. Frames for multiple openings shall be provided with mullion and/or rail members, fabricated of closed tubular shapes with no visible seams or joints. Joints between faces of abutting members shall be securely welded and finished smooth. Provide condensate weeps 4 inches on centers, maximum.
- I. Door Silencers: Except for exterior doors, drill and punch frames for three silencers at lock jamb of single swing doors or in double doors with astragal and one silencer per leaf in heads of doubled door frames.
- J. Where frames are installed in walls sitting on a concrete curb, provide a closure plate or extend backbends to provide closure where frame abuts concrete curb.

2.05 DOORS

- A. General: Custom-made, flush-panel “seamless type” with one-piece face panels; continuous weld, seamless edge construction with no visible seams or joints on faces or on vertical edges.
1. Provide type and size of doors shown with louvers and openings for glazing where indicated.
 2. Door thickness: 1 ¾ inches.
 3. Face Sheet Minimum Gage: 16 gage.
 4. Stiffeners: Stiffen door face sheets with continuous vertical-formed steel (rib) sections or back to back hat sections, minimum 20 gage, full thickness of interior space between door faces, spaced 6” on center maximum, and spot welded to both faces 4” on center maximum.
 5. Acoustical Insulation: Provide sound deadening and insulating material through entire core of door (full height, width, and thickness of door). Provide STC ratings where indicated on Drawings, scheduled, or for partition ratings indicated on Drawings.
 - a. Doors shall have a minimum STC of 28 as tested under ASTM E90 and ASTM E413, unless noted otherwise..
 6. Thermal Insulation: Exterior doors shall be insulated to R values scheduled or indicated on drawings.
 7. Labeled Doors: Where fire-rated openings and conditions are indicated.
 - a. Labeled doors shall be provided with fire-resistance rating indicated and shall be constructed as tested and approved by Underwriters’ Laboratories (UL) for installation in labeled frame and door assemblies.
 - b. Gaskets: Gaskets are supplied under Section 08 7100 - Door Hardware. Gaskets and installation shall conform to requirements of NFPA 105, “Installation of Smoke and Draft Control Door Assemblies.”
 - c. Fabricate labeled doors with same finished appearance as specified for non-labeled hollow metal doors; with welded door edges, filled and ground smooth; with label affixed to door.
 - d. Where fire labels are required and continuous hinge is specified, install label on top of door within 6” of hinge side of door.
 8. Door Edges: Join door face sheets at vertical edges of door with continuous weld full height of door. Grind, fill, and dress welds smooth to provide invisible seam with smooth, flush surface.

- a. Close ends of doors with continuous recessed channels, 16 gage steel minimum, spot welded to both face sheets. Close top and bottom edges of doors with a internal steel channel, screw attached into top and bottom of door. Channel shall be galvanized at exterior doors. No screws are allowed on visible faces of door. Provide openings in bottom closure of exterior doors to permit escape of entrapped moisture.
- b. Profile of Door Edges:
 - 1) Single-acting swing doors: Bevel both vertical edges 1/8" in 2".
 - 2) Pairs of single-acting swing doors: Bevel hinge edge 1/8" in 2". Provide surface mounted astragals for labeled or unlabeled doors unless otherwise shown on Drawings or required.
 - 3) Double-acting swing doors: Round both vertical edges on 2" minimum radius.
- 9. Door Louvers: Install according to manufacturers recommendations.
- 10. Glass Stops:
 - a. Furnish fixed stops integral with and welded at security side of door.
 - b. Finish: Factory primer.
- 11. Transom: Fabricate to requirements specified for flush doors.
- K. Hardware Reinforcement and Accessories:
 - 1. Provide sheet steel or plate reinforcement for finish hardware items wherever necessary. Mortise, drill and tap to template requirements for mortise type hardware.
 - 2. Butt reinforcing: 7 gage minimum, of length 4" longer than length of butt. Minimum 3 spot welds at top and bottom.
 - 3. Door closer reinforcement: 14 gage minimum steel channel, 6" high on each side of door.,. Reinforcement to extend full width of door in accordance with Detail #1 of this section.
 - 4. Other Hardware Requirements: Cut, reinforce, drill, and tap doors and frames for other hardware, including energy management switches or contacts and security devices, in accordance with furnished hardware templates for accessory items. Thickness and size of reinforcement shall be as required by ANSI A250.6.

2.06 SHOP PRIMING

- A. Exposed and concealed metal surfaces of hollow metal doors, frames and other hollow metal Work of this Section shall be bonderized and then shop primed.
- B. Exposed surfaces of doors, frames and accessories shall be filled, sanded smooth and cleaned before painting.
- C. Exposed surfaces shall be shop primed after assembly.

PART 3 - EXECUTION

3.01 FRAME INSTALLATION

- A. Install steel frames accurately in location, perfect alignment, plumb, straight and true. Brace frames to prevent displacement.
- B. Anchor frames in concrete and concrete unit masonry with galvanized anchor bolts; 3/8 inch diameter, counter-sunk at 24 inches on center at head and jamb unless noted otherwise.
- C. Anchor frames in steel and wood frame partitions with manufacturer recommended anchors.
- D. Install frame at fire rated openings in accordance with NFPA Standard No. 80.
- E. Furnish filler for anchor attachment screws, and sand smooth.

3.02 DOOR INSTALLATION

- A. Install steel doors in accordance with manufacturer's instructions and as indicated on Drawings and in Finish Hardware Specifications. Coordinate with Work of other trades.
- B. Ensure that door and jamb clearances comply with requirements of ANSI/NFPA 80. When wood doors are being installed in metal frames constructed pursuant to this section, allowable door and jamb clearances shall be as specified in Specification Section 08 1416.
- C. Adjust operable parts for correct function.
- D. Remove hardware, except primer-coated items, tag, box and install after finish painting has been completed.

3.03 PRIME COAT TOUCH-UP

- A. Immediately after installation, remove rust, repair damaged surfaces to new condition, sand smooth, and install touch-up primer.

3.04 CLEAN UP

- A. Remove rubbish, debris and waste materials and legally dispose of off Project site.

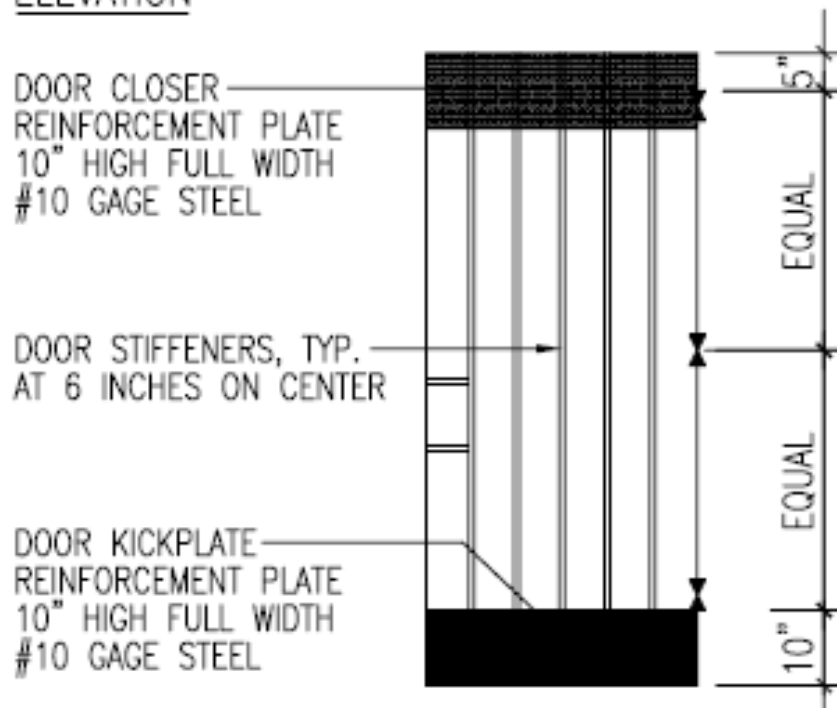
3.05 PROTECTION

- A. Protect Work of this section until Substantial Completion.

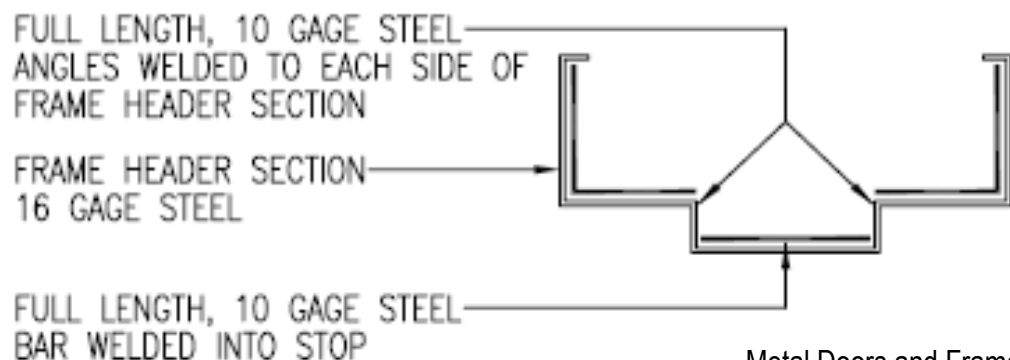
END OF SECTION

DETAIL # 1 - DOOR REINFORCEMENT

ELEVATION



DETAIL # 1 - DOOR HARDWARE REINFORCEMENT DOOR CLOSER REINFORCEMENT FOR ALL STEEL DOOR FRAMES



Metal Doors and Frames

DETAIL # 3 – CONCRETE WALL CONDITION

DETAIL FOR EXTERIOR DOOR WHERE RAIN DRIP IS REQUIRED.
EXTERIOR SIDE WITH 22 GAGE GLAVANIZED SHEET METAL OR PAINT LOCK
RAIN DRIP WELDED IN PLACE.

SPOT WELD TO FRAME AT 3 INCHES ON CENTER,
WITH WELDS WITHIN ONE INCH OF EACH END.



DETAIL # 3A – PLASTER WALL CONDITION

DETAIL FOR EXTERIOR DOOR WHERE RAIN DRIP IS REQUIRED.
EXTERIOR SIDE WITH 22 GAGE GLAVANIZED SHEET METAL OR PAINT LOCK
RAIN DRIP WELDED IN PLACE.

SPOT WELD TO FRAME AT 3 INCHES ON CENTER,
WITH WELDS WITHIN ONE INCH OF EACH END.



**SECTION 08 7100
DOOR HARDWARE**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Door hardware.
 - 2. Door Hardware Schedule.
- B. Related Requirements:
 - 1. Division 01 - General Requirements.
 - 2. Section 06 2000 - Finish Carpentry.
 - 3. Section 08 1113 - Hollow Metal Doors and Frames.
- c. Items listed in other sections and not included herein as "Door Hardware"
 - 1. Disabled access signs.
 - 2. Smoke detectors, 120VAC power, wiring, and conduit.
 - 3. Door position switches.
 - 4. Access panels, except padlocks.
 - 5. Gate hardware, except locking devices.
 - 6. Local alarms and annunciators.

1.02 DESIGN REQUIREMENTS

- A. Design Requirements:
 - 1. Exit doors, including each leaf of a pair of doors, shall always be operable from the inside by the simple turn of a lever or by pushing an exit device without the use of a key or any special knowledge or effort; this includes doors of toilet and storage rooms.
 - 2. Unless otherwise specified, hand activated door opening hardware shall be located 36 inches above the finish floor.
 - 3. Dead bolts are not permitted unless operable with a single effort by a lever type hardware.
 - 4. The force applied to operate exit hardware shall not require more than 15 lbs. applied in the direction of travel.
- B. Regulatory Requirements:

1. Comply with CBC requirements.
2. Hardware for fire doors shall conform to requirements of UL - Fire Protection and Accident Hazard Equipment and the California State Fire Marshal listing, NFPA - 80 and CBC requirements for positive pressure testing.
3. Hardware shall meet the requirements of CBC, Chapter 11B.

1.03 SUBMITTALS

A. Shop Drawings:

1. Wiring Diagrams: Submit diagrams, templates, instruction, and installation manuals, for electrical and electronic hardware.

B. Product Data: Finish Hardware Schedule:

1. Submit schedule including recap sheet:

- a. Include manufacturer's name, catalog number, relevant dimensions, fasteners, location of item in Work, door index number, frame material, door material, door size and thickness, door type, handing, fire-rating (if any), and sound-rating (if any).

- b. Hardware shall be listed by "Headings" in following manner:

1) HEADING NO. 1

1 SINGLE/PAIR OF DOORS NO. (Room and Number) from/to (Room and Number)

1 SINGLE/PAIR OF DOORS NO. (Room and Number) from/to (Room and Number)

SPEC. NO. List the appropriate numbers from the specified LIST OF FINISH HARDWARE

List of finish hardware

2) HEADING NO. 2, etc.

1.04 QUALITY ASSURANCE

- A. Each type of finish hardware furnished for the Work shall be of same make or manufacture, unless otherwise specified. Where existing items are being supplemented with new items, match existing items, subject to current code requirements and accessibility recommendations.

- B. Coordinate and deliver templates or physical Samples of finish hardware items to manufacturer of interfacing items, such as doors and frames, in a timely manner to insure orderly progress of Work.
- C. Comply with the following as a minimum requirement:
 - 1. Conform to Builders Hardware Manufacturers Association (BHMA) Finish Code, latest edition.
 - 2. DHI WDHS.3: Recommended Locations for Architectural Hardware for Wood Flush Doors
 - 3. DHI WDHS.4: Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors.
 - 4. HMMA 831: Recommended Hardware Locations for Custom Hollow Metal Doors and Frames

1.05 DELIVERY, STORAGE AND HANDLING

- A. Package each item of hardware and each lockset individually, complete with necessary installation instructions, screws and fastenings, and installation templates; marked with item number corresponding to number on Finish Hardware Schedule.

1.06 WARRANTY

- A. Manufacturer shall provide a minimum two year material warranty except as follows:
 - 1. Provide a ten year manufacturer's material warranty for door closers.
 - 2. Provide a five year manufacturer's material warranty for locksets and exit devices.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Butts and Hinges:
 - 1. Width of hinges shall be of sufficient size to clear trim. Where provided with magnetic holders, hinge width shall be of sufficient size to ensure door is parallel to wall when magnetic holders are engaged.
 - 2. Furnish one pair of hinges for door leaves up to 5-foot high. Furnish one additional hinge for every additional 30 inches or fraction thereof.
 - 3. Butts for doors shall be non-rising, loose pins, with button tip.
 - 4. Exterior and interior out-swinging doors with butt hinges shall be furnished with hinges furnished with a setscrew in hinge barrel to make pin non-

removable (NRP); exterior and interior out-swinging doors hinges shall have continuous hinges furnished with hospital tips. Butt hinges at exterior out-swinging doors shall have stainless steel pins and bearings.

5. Hinges installed on painted doors shall be BHMA 600 finishes. Hinges installed on stained and varnished doors shall be BHMA 626 for bronze/brass base metals and BHMA 652 for steel base metal. Exterior doors shall have non-ferrous hinges. Fire-rated doors shall have steel or stainless steel hinges.

B. Locksets and Trim:

1. Unless otherwise specified, locks shall be of mortise type, complying with ANSI A156.13, grade 1.
2. Unless otherwise specified, escutcheons shall be 7 ½-inch by 2 ¼-inch wide by 0.050 thick minimum.
3. Levers shall be cast, and shall return to within ½ inch of face of door.
4. Outside lever shall be pinned. Inside lever shall be by "Allen Head Set Screw" or by "Spanner Ring Nut".
5. Lock strikes shall be curved lip type, with exposed edges and corners rounded, of sufficient length to protect jamb and trim, and shall not extend more than 1/8 inch beyond trim, jambs or face of doors in pairs. At out-swinging pairs with overlapping astragal, strike shall have a 7/8 inch lip-to-center dimension. Dust box shall be provided for door locks.
6. Locksets throughout shall be lever type of same manufacture.

D. Door Closers:

1. Door closers shall conform to ANSI A156.4, Grade 1, CBC 1133B.2.5.
2. Door closers shall be heavy duty, rigid parallel arm; provide regular arm for regular bevel doors.
3. Door closer shall be full rack and pinion type, adjustable back check, and sweep and latch speed with key regulating screws.
4. Door closer shall have full fitted cover of plastic or stainless steel, attached to door closer body with tamperproof screws.
5. Provide spacer block or support bracket for securing fifth screw on closer arm shoe. Provide special brackets, shoes, or other attachment devices as required.
6. Maximum pressure to operate doors shall not exceed following:

- a. Fire rated doors: The authority having jurisdiction may determine the maximum force, not to exceed 15.0 pounds to operate fire doors to achieve positive latching.
 - b. Exterior doors: 5.0 pounds.
 - c. Interior doors: 5.0 pounds.
- 7. Door closers shall be installed at the following:
 - a. Exterior doors.
 - b. Fire rated doors.
 - c. Corridor doors.
 - d. Toilet doors.
- E. Protection Plates: Furnish kick plates of 10-inch high by 2-inch less door width on single doors, 10-inch high by 1 inch less door width on pairs of doors. Provide one plate for push side of closer-equipped doors. Furnish mop plates 4-inch high by 1 inch less door width on doors swinging into toilet rooms.
 - 1. Kick and mop plates shall be a minimum 0.050 inch thick; Type 304 stainless steel, with finished beveled edges (B4E).
- F. Stops:
 - 1. Floor stops shall be mounted to protect door and trim.
 - 2. Furnish stop of appropriate height, minimum $\frac{3}{4}$ inch above undercut of door.
 - 3. Where the specified floor stop cannot be installed or would present a pedestrian hazard, omit and furnish a heavy-duty overhead stop (626 finish); if closer is specified, furnish closer with integral spring-cushion stop arm.
- G. Weather stripping/Gasketing:
 - 1. Install gaskets and intumescent seals on fire rated doors and frames.
 - 2. Unless otherwise specified, install weather stripping on doors from air-conditioned spaces to the exterior: fastener-applied frame seals, nylon-brush door sweeps, and, at pairs, astragals.
- H. Thresholds: Unless otherwise specified, thresholds shall conform to CBC Chapter 11B accessibility standards and ADAAG.
- J. Automatic Flush Bolts:
 - 1. Strike plates for automatic bolts shall be provided for active door.

2. Provide dust proof strikes for bottom bolts.

K. Coordinators:

1. Provide brackets as required for items fastened to coordinators.

2. Provide door strike plates for both doors with coordinators.

2.02 FINISH

A. Unless otherwise specified, finish of hardware shall be dull chromium-plated BHMA 652 for steel-based metals, BHMA 626 for brass-based metals, except for kickplate, escutcheons, push plates, continuous hinges, lock strike plates, and exit device touch bars, which shall be BHMA 630. Levers for locksets and exit devices shall be BHMA 626.

B. Unless otherwise specified, overhead door closers and brackets shall be BHMA 689, to match other finish hardware in same room or space.

2.03 CYLINDERS AND KEYING

A. Project shall be keyed in accordance with keying schedule, prepared and furnished by the OAR.

B. Provide a cylinder security collar (SPEC. NO. 87) at each exterior door cylinder. Provide cylinder collars and spacers at all cylinders as needed to provide a neat, tight and secure fit of the cylinder to the locking hardware.

C. Permanent Cylinders:

1. Permanent cylinders shall be standard core type, 7-pins maximum.

a. Permanent cylinders as manufactured by [] shall be Owner furnished. The Work of this section includes obtaining the permanent cylinders from the Owner, and pinning, stamping, and installing.

2. Permanent cylinders shall be pinned with third-party (e.g., "LAB") 0.005 inch increment pins.

3. Pin cylinders according to OAR-furnished sample set of permanent keys, OAR-furnished bitting chart and OAR-furnished key schedule.

4. Change keys and master keys shall operate inside and outside cylinder on two cylinder locks, unless otherwise indicated.

5. Provide the set number of change key only stamped on cylinder faces.

D. Key Control:

1. Permanent cylinders and sample set of permanent keys shall be not used during the construction phase of the Project. Temporary construction cylinders and keys used for securing the Work is included as part of the Work of this section and will not be provided by the Owner.
2. Upon Substantial Completion of the Work, sample set of original keys shall be returned to the OAR. Duplication of Owner keys, or retaining keys, is not permitted.
3. Provide four unstamped, uncut nickel silver key blanks per cylinder to the OAR prior to Substantial Completion. Key blanks shall be by the permanent cylinder manufacturer and of the same keyway as the sample set of permanent keys or keyway designated by Owner.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Finish hardware shall be installed as specified in Finish Hardware Schedule.
 1. Placement of Hardware: Finish hardware shall be installed as indicated on hardware placement sheets attached to end of this section.
 2. Provide necessary screws, bolts, anchors, and fastenings, of required sizes and type for proper installation of hardware. Exposed screws shall have Phillips heads, and wood screws shall be fully threaded.
 3. Fitting: Hardware shall be accurately fitted and, with exception of prime-coated butt or continuous hinges, bar-type coordinators, and flat astragals, shall be removed before finish painting is installed. Upon completion of finish painting and/or sealing, permanently install the hardware.
 4. Anchorage of Hardware: Hardware fastened to concrete, masonry, or gunite construction shall be provided with drop-in expansion anchors by "Red Head Multi Set II", "Rawl Steel", or as otherwise required by hardware manufacturer. Pilot holes of suitably lesser diameter shall be drilled prior to the insertion of wood and sheet metal screws.
 5. Door escutcheons and push plates shall be installed with stainless steel or bronze, oval, "Phillips Head", fully threaded screws, not less than 3/4 inch - No. 6.
 6. Door closer shall be installed for maximum degree of opening of each door.
 7. Following shall be installed with sex nuts and fully threaded machine screws.
 - a. Door closers.
 - b. Door pulls.

8. Thresholds shall be installed with 1/4-20 screws, set in Pour-Roc or mastic per section 07 9200, and coped to trim.
9. Sound Seals and Weather stripping / Gasketing:
 - a. A mounting screw shall be installed within 2 inches of cuts or corners of weather stripping and/or gasketing.
 - b. Sound seals and weather stripping and/or gasketing shall be installed with No. 8 - 3/4 inch Tek Phillips pan head screws.

3.02 ADJUSTING AND CLEANING

- A. Before Substantial Completion, hardware shall be cleaned and inspected. Where hardware is deemed defective, repair or replace as required.
- B. Door Closers: Final adjustments shall be performed before Substantial Completion, with mechanical system balanced and in operation.

3.03 EXAMINATION

- A. Upon completion of installation, verify correct installation of hardware, according to reviewed Hardware Schedule and Keying Schedule. Verify that finish hardware is in optimum working condition.

3.04 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.05 FINISH HARDWARE SCHEDULE

- A. See plans.

END OF SECTION

SECTION 09 9000

PAINTING AND COATING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior and exterior painting.

B. Following items shall not be painted:

1. Brass valves, chromium or nickel-plated piping and fittings.
2. Boiler control panels and control systems.
3. Fabric connections to fans.
4. Flexible conduit connections to equipment, miscellaneous name plates, stamping, and instruction labels and manufacturer's data.
5. Mechanical and electrical utility lines, piping and heating and ventilation ductwork in tunnels, under-floor excavated areas or crawl spaces, attic spaces and enclosed utility spaces.
6. Flag, floodlight, parking light poles and loudspeaker poles, metal stairs, handrails and chain-link fence with a galvanized finish, unless otherwise noted.
7. Structural and miscellaneous steel, open web steel joists and metal floor decking, which will not be exposed in final construction, shall have no finish other than one coat of shop primer.
8. Hardboard covering on tops and backs of counters and benches.
9. Brass, bronze, aluminum, lead, stainless steel and chrome or nickel-plated surfaces.
10. Non-metallic walking surfaces unless specifically shown or specified to be painted.

1.02 REGULATORY REQUIREMENTS

- ###### A.
- Paint materials shall comply with the Food and Drug Administration's (F.D.A.) Lead Law and the current rules and regulations of local, state and federal agencies governing the use of paint materials.

1.03 SUBMITTALS

- A. List of Materials: Before submittal of samples, submit a complete list of proposed paint materials, identifying each material by distributor's name, manufacturer's name, product name and number, including primers, thinners, and coloring agents, together with manufacturers' catalog data fully describing each material as to contents, recommended installation, and preparation methods. Identify surfaces to receive various paint materials.
- B. Material Samples: Submit manufacturer's standard colors samples for each type of paint specified. Once colors have been selected, submit Samples of each color selected for each type of paint accordingly:
 - 1. Samples of Paint and Enamel must be submitted on standard 8 ½" x 11" Leneta Opacity-Display Charts. Each display chart shall have the color in full coverage. The sample shall be prepared from the material to be installed on the Work. Identify the school on which the paint is to be installed, the batch number, the color number, the type of material, and the name of the manufacturer.
 - 2. Elastomeric shall be submitted in duplicate samples of the texture coating. Samples will be not less than 2 ½ by 3 ½ in size and installed upon backing. Finished Work will match the reviewed Sample in texture.
 - 3. Materials and color samples shall be reviewed before starting any painting.
- C. For transparent and stained finishes, prepare samples on same species and quality of wood to be installed in the Work, with written description of system used.

1.04 QUALITY ASSURANCE

- A. Certification of Materials: With every delivery of paint materials, the manufacturer shall provide written certification the materials comply with the requirements of this section.
- B. Coats: The number of coats specified is the minimum number. If full coverage is not obtained with the specified number of coats, install additional coats as required to provide the required finish.
- C. Install coats and undercoats for finishes in strict accordance with the recommendations of the paint manufacturer as reviewed by the Architect.
- D. Paint materials shall comply with the following as a minimum requirement:
 - 1. Materials shall be delivered to Project site in original unbroken containers bearing manufacturer's name, brand number and batch number.
 - 2. Open and mix ingredients on premises in presence of the Project Inspector.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Storage and Mixing of Materials: Store materials and mix only in spaces suitable for such purposes. Maintain spaces clean and provide necessary precautions to prevent fire. Store paint containers so the manufacturer's labels are clearly displayed.

1.06 SITE CONDITIONS

- A. Temperature: Do not install exterior paint in damp, rainy weather or until surface has thoroughly dried from effects of such weather. Do not install paint, interior, or exterior, when temperature is below 50 degrees F, or above 90 degrees F, or dust conditions are unfavorable for installation.

1.07 WARRANTY

- A. Manufacturer shall provide a three year material warranty.
- B. Installer shall provide a three year application warranty.

1.08 MAINTENANCE

- A. Provide at least one gallon of each type, color and sheen of paint coating installed. Label containers with color designation indicated on Drawings.

PART 2 - PRODUCTS

2.01 PAINT MATERIALS

- A. Furnish the products of only one paint manufacturer unless otherwise specified or required. Primers, intermediate and finish coats of each painting system must all be the products of the same manufacturer, including thinners and coloring agents, except for materials furnished with shop prime coat by other trades.
- B. Factory mix paint materials to correct color, gloss, and consistency for installation to the maximum extent feasible.
- C. Paint materials to be minimum "Architectural Grade".
- D. Gloss degree standards shall be as follows:

HIGH GLOSS	70 and above	EGGSHELL	30 to 47
SEMI-GLOSS	48 to 69	SATIN	15 to 29

2.02 MANUFACTURERS

- A. Acceptable manufacturers, unless otherwise noted:
 - 1. Dunn-Edwards Corporation Paints
 - 2. Frazee Paints and Wall coverings
 - 3. Vista Paints
 - 4. Sherwin Williams

5. ICI Paints

6. Equal.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Examine surfaces to receive paint finish. Surfaces which are not properly prepared and cleaned or which are not in condition to receive the finish specified shall be corrected before prime coat is installed.
- B. New woodwork shall be thoroughly cleaned, hand sandpapered, and dusted off. Nail holes, cracks or defects in Work shall be filled. On stained woodwork, fill shall be colored to match stain. Filling shall be performed after the first coat of paint, shellac or varnish has been installed.
- C. Plaster surfaces except veneer plaster shall be allowed to dry at least 3 weeks before painting. Veneer plaster shall be allowed to dry sufficiently to receive paint as determined by moisture meter tests.
- D. Metal surfaces to be painted shall be thoroughly cleaned of rust, corrosion, oil, foreign materials, blisters, and loose paint.
- E. Do not install painting materials to wet, damp, dusty, dirty, finger marked, rough, unfinished or defective surfaces.
- F. Concrete surfaces shall be dry, cleaned of dirt and foreign materials and in proper condition to receive paint. Neutralize spots demonstrating effects of alkali.
- G. Mask off areas where necessary.

3.02 APPLICATION

- A. Backpainting: Immediately upon delivery to the Project site, finish lumber and millwork shall be backpainted on surfaces that will be concealed after installation. Items to be painted shall be backpainted with priming coat specified under "Priming".
- B. Priming: New wood and metal surfaces specified to receive paint finish shall be primed. Surfaces of miscellaneous metal and steel not embedded in concrete, and surfaces of unprimed plain sheet metal Work shall be primed immediately upon delivery to the Project site. Galvanized metal Work and interior and exterior woodwork shall be primed immediately after installation. Priming of surfaces and priming coat shall be as follows:
 - 1. Knots, Pitch and Sap Pockets: Shellac before priming.
 - 2. Exterior Woodwork and Wood Doors: Prime with one coat of exterior waterborne emulsion wood primer.

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3. Interior Woodwork: Where indicated to be painted, prime with one coat of waterborne wood primer.
 4. Stain: Woodwork indicated to receive a stain and varnish finish shall be stained to an even color with water borne stain. On open-grained hardwood, mix stain with paste filler and completely fill pores in wood.
 5. Galvanized Metal Work: Clean oil, grease and other foreign materials from surfaces. Install vinyl wash pretreatment coating. Follow manufacturer's instructions for drying time, and then prime with one coat of metal primer.
 6. Unprimed Iron, Steel, and Other Uncoated Metals: Where specified to be painted, prime with one coat of metal primer.
 7. Shop Primed Metal Items: Touch up bare and abraded areas with metal primer before installation of second and third coats.
 8. Coats shall be installed evenly and with full coverage. Finished surfaces shall be free of sags, runs and other imperfections.
- C. Allow at least 24 hours between coats of paint.
- D. Rollers shall not be used on wood surfaces.
- E. Each coat of painted woodwork and metal, except last coat, shall be sandpapered smooth when dry. Texture-coated gypsum board shall be sanded lightly to remove surface imperfections after first coat of paint has been installed.
- F. Each coat of paint or enamel shall be a slightly different tint as required. Each coat of paint, enamel, stain, shellac, and varnish will be inspected by the IOR before next coat is applied. Notify the Project Inspector that such Work is ready for inspection.
1. Tinting Guideline: The first coat, primer/undercoat(s) to be untinted or tinted up to 50 percent lighter or darker (at the discretion of the installer) than the finish coat. The second coat (or third coat if a seal coat and undercoat have been specified) is to be factory tinted in the range of 10 percent to 15 percent lighter or darker (at the discretion of the installer) than the finish coat. The final coat is to be factory tinted to the required color selected. These tinting guidelines shall be provided on all surfaces receiving paint.
- G. Do not "paint-out" UL labels, fusible links and identification stamps.
- H. Paint Roller, brush and spray.
1. Only Paint rollers shall be used on interior plaster, drywall, masonry/plaster and plywood surfaces, nap shall not exceed one half inch in length.
 2. First coat on wood overhang and ceilings shall have material applied by roller and then brushed out in a professional manner to leave surface free of imperfections. Finish coat may be sprayed.

- 3. Other surfaces shall have all coatings applied with brushes of proper size.
- 4. Spray work is permitted only on radiators, acoustic plaster, masonry and plaster.
- I. Where ceilings are specified to be painted, beams, cornices, coves, ornamental features, plaster grilles, etc. shall be included.
- J. Ceilings shall be white, including classrooms, storage rooms, offices, arcades, etc. Boiler room and fan room ceiling color shall match adjacent walls.

3.03 CLEANING

- A. Remove rubbish, waste, and surplus material and clean woodwork, hardware, floors, and other adjacent Work.
- B. Remove paint, varnish and brush marks from glazing material and, upon completion of painting Work, wash and polish glazing material both sides. Glazing material, which is damaged, shall be removed and replaced with new material.
- C. Clean hardware and other unpainted metal surfaces with recommended cleaner. Do not furnish abrasives or edged tools.

3.04 SCHEDULE

- A. Interior:
 - 1. Woodwork, Painted: 3 coats.
 - a. First Coat: As specified in this section under Priming.
 - b. Second and Third Coats: Interior enamel, semi-gloss or gloss as indicated.
 - 2. Woodwork, Stained and Varnished: 4 coats.
 - a. First Coat: As specified in this section under Priming.
 - b. Second, Third and Fourth Coats: Varnish, semi-gloss.
 - 3. Wood Corridor doors: 4 coats.
 - a. First Coat: As specified in this section under Priming.
 - b. Second, Third, and Fourth Coats: Varnish, gloss.
 - 4. Other Wood Doors: 4 coats.
 - a. Varnished or painted as indicated.
 - b. If varnished, same finish system as painted woodwork, with semi-gloss or gloss finish to match adjacent wall.

5. Miscellaneous Woodwork: 4 coats. Wood items including, but not limited to: stair treads and risers, handrails, rolling ladders, wood base and shoe, chair rails, counter tops and locker room benches.
 - a. First Coat: As specified in this section under Priming.
 - b. Second, Third and Fourth: Exterior varnish, gloss.
6. Casework: Interior surfaces of casework (except plastic laminate-faced casework) including top, edges and underside of shelving, poles, surfaces of drawers (except fronts), interior surfaces of mailbox pigeonholes, and particle board.
 - a. First Coat: Waterborne stain.
 - b. Second and Third Coats: Satin varnish.
7. Plaster: 4 coats.
 - a. First Coats: Pigmented wall sealer.
 - b. Second coat: Enamel under coater.
 - c. Third and Fourth Coats – Interior enamel, semi-gloss or gloss as indicated.
8. Gypsum Board: 4 coats.
 - a. First Coat: Drywall sealer.
 - b. Second Coat: Enamel under coater.
 - c. Third and Fourth Coats: Interior enamel, semi-gloss or gloss as indicated.
9. Concrete: 3 coats.
 - a. First: Concrete sealer.
 - b. Second and Third: Interior enamel, semi-gloss or gloss as indicated.
10. Concrete Block: 3 coats.
 - a. First: Concrete block filler.
 - b. Second and Third: Interior enamel, semi-gloss or gloss as indicated.
11. Metal: Shall be cleaned, pre-treated and painted with 3 coats. Items to be painted include, but are not limited to: exposed structural and miscellaneous steel, metal doors and frames, ladders, table and bench legs.
 - a. First Coat: Metal primer.

- b. Second and Third Coats: Interior gloss enamel, except metal doors and frames which shall be semi-gloss or gloss to match adjacent wall.

B. Exterior:

- 1. Woodwork: 3 coats.
 - a. First Coat: As specified in this section under Priming.
 - b. Second and Third Coats: Exterior house and trim enamel.
- 2. Wood Doors: 3 coats.
 - a. First Coat: As specified in this section under Priming.
 - b. Second and Third Coats: Exterior gloss enamel.
- 3. Plaster and Stucco: 3 coats. Flat 100 percent acrylic.
 - a. Prime Coat: Alkali resistant primer/sealer.
 - b. Exterior 100 percent acrylic.
- 4. Concrete: 3 coats. Flat 100 percent acrylic.
 - a. First Coat: Concrete sealer.
 - b. Second and Third Coats: Exterior 100 percent acrylic.
- 5. Concrete Block: 3 coats. Flat 100 percent acrylic.
 - a. First Coat: Concrete block filler.
 - b. Second and Third Coats: Exterior 100 percent acrylic.
- 6. Metal: 3 coats. Shall be cleaned and pre-treated. Items to be painted include, but are not limited to: steel columns and miscellaneous steel items, gravel stops, metal doors and frames, hoods and flashings.
 - a. First Coat: As specified in this section under Priming.
 - b. Second and Third Coats: Exterior gloss enamel.

C. Mechanical and Electrical Work:

- 1. Except where interior mechanical and electrical Work to be painted is specified to receive another paint finish, Work occurring in finished rooms and spaces shall be cleaned, pre-treated, and painted with 3 coats. Items to be painted include, but are not limited to: steel and copper piping, pipes, vents, fittings, ducts, plenums, miscellaneous supports

and hangers, electrical conduit, fittings, pull boxes, outlet boxes, unfinished surfaces of plumbing fixtures, miscellaneous metal cabinets, panels, and access doors and panels.

- a. First Coat: As specified in this section under Priming.
- b. Second and Third Coats: Interior enamel, semi-gloss or gloss to match adjacent wall or ceiling finish.

2. Insulation and Taping on Pipes and Ducts: 3 coats.

- a. Finished Rooms:
 - 1) First Coat: Interior waterborne primer.
 - 2) Second and Third Coats: Interior semi-gloss or gloss enamel to match adjoining wall or ceiling finish.
- b. Building Exterior:
 - 1) First Coat: Exterior waterborne primer.
 - 2) Second and Third Coats: Exterior gloss enamel.

3. Inside surfaces of ducts, vents, dampers and louvers as far back as visible from room in which they open shall be painted with 2 coats of flat black paint.

D. Miscellaneous:

- 1. Outside Storage Units (wood or metal): 3 coats.
 - a. First Coat: As specified in this section under Priming.
 - b. Second and Third Coats: Exterior gloss enamel.
- 2. Exterior and interior surfaces of storage bins, and potting tables shall have 3 coats of acrylic stain.
- 3. Wood compost bins shall be finished with 3 coats of acrylic stain.

3.05 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.06 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

**SECTION 22 0500
COMMON WORK RESULTS FOR PLUMBING**

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. This Section provides the basic plumbing requirements that apply to the Work of Division 22.

B. Related Requirements:

1. Division 01: General Requirements.
2. Division 22: Plumbing
3. Division 23: HVAC
4. Division 26: Electrical.

1.02 REGULATORY REQUIREMENTS

- A.** Current federal Safe Drinking Water Act (SDWA) regulations require the furnishing of lead-free pipe, solder, and flux in the installation or repair of plumbing in non-residential facilities connected to public drinking water systems. Under this regulation, solders and flux are considered lead-free when they contain 0.2 percent lead or less. Under California regulations pipes and pipe fittings are considered lead-free when they contain 0.25 percent lead or less as defined in California Assembly Bill 1953 (AB 1953). No pipe, pipe fittings, or any other fitting or fixture intended to convey or dispense water for human consumption by drinking or cooking is allowed in the domestic plumbing system, if they do not meet the low lead definition of AB 1953. Weighted average lead content of the wetted surface area of pipes, fittings and fixtures may not exceed 0.25 percent.

1. Provide lead-free water pipe, solder, and flux materials that meet the standards as outlined by the federal SDWA regulations and California AB 1953 if installed in drinking water system.
2. Collect pipe, solder, and flux material samples as required by the Project Inspector. Test samples shall be delivered to an Owner designated testing laboratory for testing of lead content.
 - a. Test samples for lead content by the atomic absorption spectrophotometry method.
3. Materials found not conforming to SDWA and California AB 1953 regulations shall be deemed defective Work and shall be replaced with lead-free materials.
4. Comprehensive testing of the remaining materials for their lead content shall be performed as required by the Project INSPECTOR.

- A.** Materials, fabrication, equipment, and installation shall comply with industry standards and code requirements. Where manufacturer's recommendations

the minimum standard. As a minimum, standards from the following organizations shall apply:

1. ANSI - American National Standards Institute.
 2. ASME - American Society of Mechanical Engineers.
 - a. ASME Boiler and Pressure Vessel Code.
 - b. ASME B31 - Standards for Pressure Piping.
 3. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers.
 4. ASTM - American Society for Testing and Materials.
 - a. ASTM A53 Specification for Welded and Seamless Pipe.
 5. AWWA - American Water Works Association.
 6. CSA - Canadian Standards Association.
 7. FM Global - Factory Mutual Global
 8. IAPMO - International Association of Plumbing and Mechanical Officials.
 9. NFPA - National Fire Protection Association.
 10. OSHA - Occupational Safety and Health Administration.
 11. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
 12. UL - Underwriters Laboratories Inc.
 13. Intertek (ETL Certification).
- B. Materials, fabrication, equipment, and installation shall comply with federal, state, and local codes including, but not limited to, the following:
1. CBC, California Building Code, and CMC, California Plumbing Code.
 - a. Latest edition as adopted by the City of Los Angeles, the County of Los Angeles, and the State of California including amendments effective on the Effective Date of the Contract.
 2. California Code of Regulations, Title 8, Industrial Relations, Division 1, Chapter 4, Division of Industrial Safety.
3. OSHA - Occupational Safety and Health Administration.
4. CDPH - California Department of Public Health.
 5. SCAQMD - South Coast Air Quality Management District.
- C. Specifications or Drawings shall not be construed to permit deviation from the requirements of governing codes unless approval has been obtained from legally constituted authorities having jurisdiction, and the Architect. The Contract Documents may contain more stringent requirements than those legally required.
- D. Permits and Fees: Refer to the General and Supplementary Conditions.

1.03 SUBMITTALS

- A. Provide submittals in accordance with Section 01 3300: Submittal Procedures and with specific requirements of Division 22 sections, as applicable.
- B. The above information shall become the basis for inspecting and testing materials and actual installation procedures performed in the Work.
- C. Shop Drawings: Submit one additional copy when control diagrams having line voltage connections are indicated. Shop Drawings shall be specifically prepared for the Work of this Project. Drawings prepared in accordance with requirements of Section 01 3113: Project Coordination and Section 01 3300 may be provided by the Architect to serve as a background for the Shop Drawings. Shop Drawings shall comply with the requirements of Section 01 3113 and Section 01 3300 and shall indicate at a minimum:
 - 1. Complete system layout of equipment, components, plumbing fixtures, piping, indicating service clearances, and pipe sizes, fitting types and sizes and pipe elevations, distances of pipes and equipment from building reference points and hanger support locations. The above items shall be coordinated on the shop drawings according to the requirements of Section 01 3113.
 - 2. Schedule and description of equipment, piping and fittings.

1.04 PROJECT RECORD DOCUMENTS

- A. Comply with provisions of Section 01 7700: Contract Closeout.
- B. Project Record Drawings:
 - 1. Provide a complete set of plumbing and fire protection drawings in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks and plotter pen color/line thickness settings on CD-ROM. Also submit one set of full size reproducible plots on vellum and 3 sets of prints.
 - 2. Before Contract Completion, deliver corrected and completed prints to the OAR. Delivery of project record documents to the OAR does not relinquish responsibility of furnishing required information omitted from project record documents.
- C. Operation and Maintenance Manuals:
 - 1. Submit two copies of operation and maintenance manuals in required form and content. If no revisions are required, furnish one additional copy. If revisions are required, one copy shall be returned with instructions for changes; perform such changes and return three copies of manuals. Manuals shall be bound in accordance to Section 01 7700. Deliver manuals to the OAR. Submit an electronic copy of the entire manual in PDF file format.
 - 2. Contents of Manual:
 - a. Title sheet with Project name, including names, addresses and telephone number of Contractor, installer, and related equipment suppliers.

- b. Manufacturer's operating instructions including, but not limited to, the following:
 - 1) Identification of components and controls.
 - 2) Trouble shooting checklist and guidelines.
 - 3) Recommendations for optimum performance.
 - 4) Warnings and safety precautions on improper or hazardous operational procedures or conditions
- c. Manufacturer's product data and parts and maintenance booklet for each item of equipment furnished under Division 22 that includes the following as a minimum:
 - 1) Manufacturer's model, identification and serial numbers.
 - 2) Exploded view of assembly drawings identifying each component or part with the relevant part number.
 - 3) Directory of manufacturer's representatives, service contractors and part distributors.
 - 4) Maintenance and trouble-shooting instructions, including schedule for preventive maintenance, periodic inspection and cleaning criteria.
- d. Project Record Drawings: Complete set of plumbing, fire protection and control system drawings in 50 percent reduced print format shall be furnished with the manual. Submit the above record drawings on CD-ROM in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks, and plotter pen color/line thickness settings.
- e. Testing, Adjusting, and Balancing reports: Submit as specified in Section 23 0593.
- f. South Coast Air Quality Management District (SCAQMD) permits to install and operate boilers, water heaters and other fuel burning equipment and third-party source test reports as required by SCAQMD to allow start-up and operation of equipment.
- g. Los Angeles County industrial waste permits.
- h. Valve directory complete with location, function, size, and model of each valve with reference to the project record drawings.
- i. Equipment and component identification chart complete with location, function, size, and model of each equipment or component with reference to the project record drawings.

1.05 COORDINATION

- A. Contract Documents indicate extent and general arrangement of Work under Division 22. Contractor shall coordinate work in accordance with Section 01 3113 requirements and make adjustments as required to provide maximum headroom, a

neat arrangement to keep passageways and openings clear to provide accessibility and provisions for maintenance, and to meet code requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Storage: Deliver materials to Project site in their original unopened containers with labels intact and legible at time of delivery. Store in strict accordance with manufacturer's recommendations.
- B. Do not store plastic pipe or materials in direct sunlight.

1.07 PRELIMINARY OPERATION

- A. OAR may require any portion of plumbing Work to be operated before Substantial Completion. Such operation shall be in addition to regular tests, demonstrations and instructions required under the Contract Documents, and shall be performed as required.
- B. Notify the INSPECTOR at least 24 hours in advance of lighting or re-lighting pilots.

1.08 TRAINING OF OWNER PERSONNEL

- A. Training of Owner's personnel shall include:
 - 1. A minimum of 4 hours of on-site overview of the overall Plumbing System.
 - 2. Refer to Division 22 sections for specific training on each of the components of the Plumbing System.
- B. Contract shall include the cost of training Owner operation and maintenance personnel in operating, adjusting, maintenance, trouble-shooting, and Project site repair of each component, equipment, or system provided under this Contract.
- C. Operational and maintenance training shall be conducted on the Project site, unless indicated otherwise.
- D. Upon completion of Owner training, a completion certificate indicating the nature of the training and a description of the systems, complete with equipment and component lists shall be issued to each trainee. The certificate should be issued in duplicate with one copy retained by OAR.
- E. An attendance sheet with the names and signatures of all participants attending the training shall be submitted to the OAR and kept as part of the project documents.

1.09 GUARANTEES AND DAMAGE RESPONSIBILITY

- A. Sound of water flowing in piping shall not be transmitted to building structure. Operation of mechanical system shall not produce operational sounds that can be heard outside of rooms enclosing apparatus or equipment.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Unless otherwise specified, materials and equipment shall be new, in good and clean condition. Equipment, materials, and components shall be of the make; type and model number noted on Drawings or specified. Pieces of equipment of the same type shall be by the same manufacturer.

- B. Whenever an item is listed by a single proprietary name, with or without model number and type, it shall be for purpose of design only, to indicate characteristics and quality desired. Proprietary designation listed on Drawings, or listed first in Specifications, is used as a basis for design to establish a standard for quality and performance and space requirements.
- C. Equipment and materials indicated or required to be installed outdoors shall be of the type that is designed, manufactured, listed or approved by authorities having jurisdiction for outdoor installation by being resistant to the adverse effects of weather. The additional protective measures against outdoor weather required by the manufacturers' installation instructions and prevalent practice shall be provided.
- D. For substitution of materials or products, refer to the General Conditions.

PART 3 – EXECUTION

3.01 SERVICE INTERRUPTIONS, OFF-SITE, GAS AND WATER

- A. Schedule Work so there shall be no service interruptions of existing systems or systems during normal hours of operation of affected systems and facilities.
- B. When service interruptions are mandatory, arrange in advance with the OAR as to time and date of such interruptions.
- C. Systems, which are interrupted, shall be returned back into operation in such manner that they will function as originally intended.

3.02 CUTTING, NOTCHING, AND BACKING

- A. Conform to California Building Code, Title 24, Part 2, for notches and bored holes in wood and for pipes and sleeves embedded in concrete and for cuts in steel, as detailed on structural Drawings.
- B. Where pipes pass through, or are located within one inch of any construction element, install a resilient pad, ½ inch thick minimum, to prevent contact.
- C. Furnish provisions for recesses, chases, and accesses and provide blocking and backing for proper reception and installation of plumbing Work.

3.03 LOCATION OF PIPING AND EQUIPMENT

- A. Location of piping, apparatus and equipment indicated on the Drawings is approximate and shall be altered to avoid obstructions, preserve headroom, and provide free and clear openings and passageways.
- B. Trenches parallel to footings shall not be closer than 18 inches to the face of footings and shall not be below a plane having a downward slope of 2 horizontal to one vertical, from a line 9 inches above bottom of footing.
- C. Pipe in tunnels shall be installed close to one side of tunnel to provide maximum space for passage. Pipe shall not be installed through crawl hole unless otherwise specified or detailed on Drawings.
- D. Place equipment in locations and spaces indicated, disassemble and/or reassemble equipment as required by Project conditions.

3.04 TESTS AND TESTING

- A. Tests shall be as required under the applicable sections of Division 22, including this Section.
- B. Additional tests may be required in the case of products, materials, and equipment if:
1. Submitted items are altered, changed, or cannot be determined as exactly conforming to the Contract Documents.
 2. Performance testing and results may also be required on certain items which are as specified, including fan, and pump performance.
- C. Piping Tests:
1. Perform tests required to demonstrate that operation of plumbing systems and their parts are in accordance with Specifications covering each item or system, and furnish materials, instruments and equipment necessary to conduct such tests. Tests shall be performed in presence of the Inspector, and representatives of any governmental agency having jurisdiction. Work shall not be concealed or covered until required results are provided.
 2. If required tests are not performed, Owner may provide in accordance with the Contract Documents.
 3. Pressure gauges furnished in testing shall comply with CPC. Air shall be bled from lines requiring hydrostatic or water tests.
 4. Systems shall be pressure-tested in accordance with pipe testing schedule below. Pipe test shall indicate no loss in pressure after a minimum duration of 4 hours at test pressures indicated. Where local codes require higher test pressures than specified herein for fire sprinkler systems, local codes shall govern.
 5. Fuel gas lines shall be first tested with piping exposed, before backfilling trenches or lathing; second with piping in finished arrangement, backfilled and paved where required, and walls finished.
 6. Piping systems may be tested as a unit or in sections, but entire system shall successfully meet requirements specified herein, before final testing by the Inspector.
 7. Repair of damage to pipes and their appurtenances or to any other structures resulting from or caused by these tests, shall be provided.
- D. Pipe Testing Schedule:

System Tested	Test Pressure (psig)	Test With:
Durham system, glass or plastic acid waste, vent and roof drain (except pipes running under a slab or underground)	Fill with water to top of highest vent; allow to stand two hours, or longer, as required by Inspector. Minimum head required for any joint shall be 10 feet in building.	Water
Cast-iron soil, waste and interior downspout, condensate drain from air conditioning equipment	10 feet of water, vertically	
Storm water disposal lines	Running water test	Water

Vacuum pump or condensate pump discharge and condensate return piping	150	Water
Domestic water piping	200	Water
Standpipes, wet or dry	300	Water
Fire sprinkler piping	200	Water
Gas piping(steel threaded or plastic)	60 (both tests)	Air
Gas piping (steel welded)	100 (both tests)	Air
Gas welding station	1-1/2 Working pressure 100 min.	Dry nitrogen
Compressed air piping	175	Air

E. Equipment Performance Assurance Tests:

1. Before operating any equipment or systems, a thorough check shall be performed to determine that systems have been flushed and cleaned as required and that equipment has been properly installed, aligned, lubricated, and serviced. Factory instructions shall be checked to verify installations have been completed and recommended lubricants have been installed in bearings, gearboxes, crankcases, and similar equipment. Particular care shall be furnished in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Equipment shall also be checked for damage that may have occurred during shipment, after delivery, or during installation. Damaged equipment, products, and materials shall be replaced or repaired as required.
2. Upon completion of the above, adjust the system settings to within normal operating conditions to prevent the system from being damaged upon start-up.
3. Run-test the equipment after start-up for five consecutive days. Tests shall include operation of all equipment and systems for a period of not less than two 8 hour periods at 90 percent of the full specified capacities.
4. Equipment Start-up Reports: For each equipment or system on which start-up is performed, submit 8 copies of start-up report for review by the Architect.
 - a. The start-up report shall include the manufacturer's standard start-up form completed and signed by the start-up technician.
5. Provide, maintain, and pay costs for equipment, instruments, and operating personnel as required for specified tests.
6. Provide electric energy and fuel required for tests.
7. Final adjustment to equipment or systems shall meet specified performance requirements.
8. Equipment, systems, or Work deemed defective during testing shall be replaced or corrected as required. Test until satisfactory results are provided.

F. Specific Coordinated Plan for Test and Balance:

1. Provide a narrative of the operational intent that clearly describes the function and sequence of operation of each component, equipment, or system installed. Instruct designated Owner personnel in the operation of the installed systems.
2. Prior to final test and balance, plumbing equipment and systems shall be operated and tested as indicated in Article 3.04.F above to demonstrate satisfactory overall operation of the installed systems.
3. Welding performed as part of this Division may be subject to radiographic inspections at random in accordance with requirements specified in Section 22 0513: Basic Plumbing Materials and Methods.

3.05 NOISE AND VIBRATION REDUCTION

- A. Correct noise or vibration caused by plumbing systems. Provide all necessary adjustments to specified and installed equipment and accessories to reduce noise to the lowest possible level
- B. Correct noise or vibration problems caused by failure to install work in accordance with Contract Documents. Include all labor and materials required as a result of such failure. Pay for re-testing of corrected noise or vibration problems by the project acoustical consultant including travel, lodging, test equipment expenses, etc.

3.06 PROTECTION, CARE AND CLEANING

- A. In addition to storage criteria of the General Conditions, and provisions under Section 01 5000: Construction Facilities and Temporary Controls, the following shall be provided:
 1. Provide for the safety and good condition of materials and equipment until Substantial Completion. Protect materials and equipment from damage.
 2. Protect installed Work.
 3. Replacements: In case of damage, immediately provide repairs and/or replacements as required.
 4. Protect covering for bearings, open connections to tanks, pumps, compressors and similar equipment.
 5. Interior of piping shall be maintained free of dirt, grit, dust, and other foreign materials.
6. Fixtures, piping, finished brass or bronze, and equipment shall have grease, adhesive, labels, and foreign materials removed. Chromium, nickel plate, polished bronze or brass Work shall be polished. Glass shall be cleaned inside and out.
7. Before initial start-up and again before Substantial Completion, piping shall be drained and flushed to completely remove grease and foreign matter. Pressure regulating assemblies, traps, strainers, boilers, flush valves, and similar items shall be thoroughly cleaned. Tag system with an information tag listing responsible party and date of element, before initial

start-up and again before Substantial Completion. Compressed air, oil, and gas piping shall be blown out with oil-free compressed air or inert gas.

END OF SECTION

SECTION 22 0513
BASIC PLUMBING MATERIALS AND METHODS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. This Section prescribes basic materials and methods generally common to the Work of Division 22.

B. Related Requirements:

1. Division 01: General Requirements.
2. Division 22: Plumbing.
3. Division 23: HVAC.
4. Division 26: Electrical.
5. Section 32 8413: Potable Water Irrigation.
6. Section 32 8426: Reclaimed Water Irrigation.
7. Division 33: Site Improvements.

1.02 SUBMITTALS

- A. Provide in accordance with Division 01, Section 22 0500 and specific requirements of each section of Division 22.
- B. Types of welding rods to be used.

1.03 QUALITY ASSURANCE

- A. Standards: Comply with applicable national, state, and local codes and standards: ASTM, ASME, and ANSI. Federal Specifications, AWWA, SISPI, NFPA, FM, UL, CPC (California Plumbing Code), CMC (California Plumbing Code), CSA.
- B. Conform to provisions of Section 22 0500: Common Work Results for Plumbing.
- C. Manufacturer of plumbing products must be third-party certified to ANSI/NSF Standard 61, Section 9 certification, and ANSI/NSF 372 to demonstrate compliance with the federal requirements for lead contribution to drinking water, the Safe Drinking Water Act SDWA, and the California Health and Safety Code Section 116875.

- D. Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production as reviewed by the ARCHITECT.

1.04 COORDINATION

- A. Coordinate related Work in accordance with provisions of Section 01 3113: Project Coordination.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Provide the following products if they are indicated in the Contract Documents or if they are required for the proper installation, function or operation of equipment, systems or components indicated in the Contract Document.
- B. Provide the following products as a complete assembly with required accessories for a complete and functioning entity in compliance with governing codes and applicable standards as specified in Section 22 0500, manufacturer's instructions or as required.
 - 1. Omission of minor details in the Contract Documents does not waive and/or otherwise relinquish compliance with the above requirements.

2.02 MANUFACTURERS AND MATERIALS

- A. Ball Valves: 2-inch and smaller:

BV-1: Class 150, 600 psi, Bronze, CWP two piece construction with reinforced TFE seats, full port, adjustable packing gland, (no threaded stem designs allowed), threaded or solder ends.

Manufacturer: NIBCO T-685-66-LF/S-685-66-LF, Hammond UP8303A/UP8513, Milwaukee UPBA400S/ UPBA450S, or equal.

BV-2: Class 150, 600 psi, Stainless Steel, CWP two piece construction with reinforced TFE seats, full port, adjustable packing gland, (no threaded stem designs allowed), threaded or solder ends.

Manufacturer: NIBCO T-585-S6-R-66-LL, Milwaukee BA260, or equal.

Ball Valves in Insulated Piping: Use extended operating handle of non-thermal conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied. NIBCO Nib-Seal Handle.

- B. Butterfly Valves:

BFV-1 Centerline Series A, 200 psi CWP tight shut-off.

- 1. Body: Lug type ductile iron. Suitable for bi-directional dead-end service at rated pressure without use of downstream flange.

2. Disc: Bronze, or aluminum bronze.
3. Stem: One or two-piece, 400 series stainless steel.
4. Seat and O-Rings: EPDM.
5. Upper and Lower Stem Bearings: Copper alloy or non-metallic material.
6. Operators: Valves 6 inches and smaller, with lever handle. Valves 8 inches and larger, with manual gear operator and disc position indicator.
7. Manufacturers:
 - a) Valves 2.5 to 6-inch: Milwaukee ML 233E, Hammond 6411-03, or equal.
 - b) Valves 8-inch and larger: Milwaukee ML 333E, Hammond 6411-03, NIBCO LD 2000, or equal.

C. Check Valves:

1. Bronze, 2-inch and smaller:

CHV-1: 200 psi, CWP horizontal swing, Y pattern, renewable seat and disc, threaded ends.

Manufacturer: NIBCO T-413-Y-LF, Milwaukee UP-509, Hammond UP-904, or equal.

CHV-2: 200 psi, CWP, bronze body, horizontal swing, Y pattern, renewable seat and disc, solder ends.

Manufacturer: Nibco S-413-Y-LF, Hammond Up-943, or equal.

CHV-3: Class 125, 200 psi, swing check, bronze body, Teflon disc, soldered ends.

Manufacturer: Stockham B-310TY, Crane 1340, NIBCO S-413-Y, Milwaukee 1509-T, Hammond IB-912, or equal.

2. Cast Iron 2 1/2-inch and larger:

CHV-4: Class 125, 200 psi, CWP, IBBM, renewable seat and disc, bolted cap, threaded ends:

Manufacturer: Crane 372, Stockham G-927, NIBCO T-918-B, or equal.

CHV-5: Special low-pressure check valve for installation in gas lines.

Manufacturer: Circle Seal Products Co., 119B-xPP; 0-15 psi; #1:1/8 inch IPS; #2:1/4 inch IPS #3:3/8 inch IPS.

D. Earthquake Valve:

EQV-1: Mechanically triggered by seismic movement, complying with state of California seismic response specifications, UL listed and certified by D.S.A. Size

and pressure as required or indicated on Drawings. (Minimum 1/4 psi, maximum 10 psi. Earthquake valve shall shut off gas automatically during an earthquake to prevent an explosion or fire. Valve shall be Koso California seismic valve, or equal.

1. Not sensitive to vibrations caused by passing trucks or accidental bumping.
2. Sensitive to wide amplitude G's only. Preset at factory for the correct G-rating.
3. Positive sealing from minus 10 degrees F. to 150 degrees F.
4. Visual open-close indicator.
5. Manual reset.
6. Plumb line for mounting.
7. Tripping mechanism has non-creeping rolling latch.
8. Install valve per manufacturer's recommendations only.

E. Expansion Tank:

ET-1: Pressurized, vertical, steel expansion tank for potable water systems with FDA approved, replaceable, heavy duty, butyl rubber blend diaphragm, polypropylene lined dome, 1/2 inch, 3/4 inch, 1 inch or 1 1/2-inch NPT system connection, 1/2 inch or 3/4 inch drain, 0.302 inch-32 standard automobile tire valve type charging connection, lifting rings and a floor mounting skirt for vertical installation. The tank must be constructed in accordance with Section VII of the ASME Boiler and Pressure Vessel Code and stamped for 125 psi working pressure. The tank must be also rated for a continuous working temperature of 240 degrees F. Provide weather and rust resistant coating.

Manufacturer: Bell and Gossett, Wheatley, Taco, Amtrol, or equal.

F. Flow Control Valve – Manual:

FC-1: Flow control valves: Bell and Gossett Series CB circuit setter balancing valve, line size, with integral pointer (to register degree of valve opening), differential pressure meter connections with built-in check valves and lockable memory stops. Manufacturer: Armstrong ARMFLO circuit-balancing valves, series CBV, or equal.

G. Gate Valves:

1. Bronze, 2-inch and smaller:

GV-1: Class 125, 200 psi, CWP, bronze body and bonnet, non-rising stem, inside screw, screw-in bonnet, solid disc, threaded ends:

Manufacturer: NIBCO T-113-LF, Milwaukee UP105-P2, Hammond UP645, or equal.

GV-2: Same as GV-1, except solder ends:

Manufacturer: NIBCO S-113-LF, Milwaukee UP115, Hammond UP647, or equal.

2. Bronze, 2-1/2-inch and larger:

GV-3: Class 125 250 psi CWP iron body, flanged ends, bolted bonnet with wheel handle, resilient wedge, non-rising stem.

Manufacturer: NIBCO F-619-RW, or equal.

GV-4: Class 125, 250 psi CWP iron body, flanged ends, bolted bonnet with 2-inch operating nut, resilient wedge, non-rising stem, fusion bonded epoxy coated.

Manufacturer: NIBCO F-619-RW-SON, or equal.

GV-5: Class 250, 250 psi, CWP, O S and Y, IBBM, resilient seat gate valve, flanged ends.

Manufacturer: Watts 408-OSYRW, or equal.

GV-6: Class 125, 200 psi CWP, bronze body and bonnet non-rising stem, inside screw, screw-in bonnet, solid disc, threaded ends.

Manufacturer: Hammond IB645, Crane 1701, Milwaukee 105, American 3F, NIBCO T-113, or equal.

H. Globe Valves:

1. Bronze, 2-inch and smaller:

GLV-1: Class 125, 200 psi, CWP, screw-in bonnet, Teflon disc, threaded ends:

Manufacturer: Milwaukee UP502-P2, Hammond UP440-P2, or equal.

GLV-2: Class 125, 200 psi, CWP, screw in bonnet, Teflon disc, soldered ends.

Manufacturer: Hammond UP418, Milwaukee UP1502, or equal.

I. Heater Vent Pipe:

1. Schedule Number:

HVP-1 Shall be UL approved for service specified. Concealed heater vent pipe, including pipe in or through attic spaces, shall be Los Angeles City approved double wall metal vent pipe. For recessed wall heaters, furnish B.W. type. All others may be Type B, or B.W. Clearances must comply with Los Angeles City code and conditions of UL listing.

Manufacturer: American Metal Products Co., Inc., Simpson Dura-Vent, AmeriVent, Hart & Cooley Mfg. Co., Metalbestos, or equal.

J. Liquid Level Gage:

LLG-1 Refrigerant type, carbon steel with stainless steel trim or all forged steel construction, back-seating standard design. Upper and lower valve furnished with ball check valves; 1/2 inch diameter glass on center. Four 3/16 inch diameter gage glass guard rods or slotted steel guard.

Manufacturer: Peneberthy, Henry, Conbraco, or equal.

K. Piping and fittings:

1. Piping shall be continuously and permanently marked with manufacturer's name, type of material, size, pressure rating, and the applicable ASTM, ANSI, UL, or NSF listing. On plastic pipe, date of extrusion must also be marked.
2. Underground non-ferrous pressure pipes shall be installed with proper color tracer wires. Refer to color code provisions in Section 22 0553: Plumbing Identification.

P-1: Cast iron: Hubless, service weight, ASTM A888, CISPI 301, conforming to CISPI 310 and installed in accordance to IAPMO IS 6.

Manufacturer: American Foundry, Tyler, AB & I, or equal.

PF-1a: Cast iron, soil or waste no-hub coupling with neoprene gaskets, stainless steel corrugated shields and stainless steel clamps. 2 bands for size 1 ½-inch thru 4-inch, IAPMO, ASTM C 564 and CISPI 310.

Manufacturer: American Foundry, Tyler, AB & I, or equal.

PF-1b: Cast iron, soil or waste, Heavy-duty no-hub coupling with neoprene gaskets, stainless steel corrugated shields and stainless steel clamps. 4 bands for size 5-inch thru 10-inch. IAPMO, ASTM C564 and CISPI 310.

Manufacturer: American Foundry, Tyler, AB & I, or equal.

PF-1c: Same as PF-1a with Heavy Duty Husky SD 4000 Coupling and stainless steel clamps. IAPMO, ASTM C564 and CISPI 310.

P-2: Galvanized steel, Schedule 40, ASTM A53.

Manufacturer: US Steel or equal.

PF-2: Malleable iron, Class 150, threaded, galvanized, beaded, ANSI B 16.3.

Manufacturer: Stockham, Stanley Flagg, Grinnell, or equal.

P-3: Copper drainage tube, inside structure and above grade. Type DWV hard temper, ASTM B 306.

Manufacturer: Mueller, Anaconda, Cerro Brass, Cambridge-Lee, Halstead, or equal.

PF-3: Cast brass drainage fittings ASA B 16.23, ASTM B 42.

Manufacturer: Mueller Brass, Nibco, Stanley Flagg, Lee Brass, or equal.

P-4: Copper water tube, Type L hard, ASTM B88. (For above ground use only.)

Manufacturer: Mueller, Cambridge-Lee, Halstead, or equal.

PF-4a: Copper Press-Connect pressure fittings, comply with ASME B16.51 "Copper Alloy Press-Connect Pressure Fittings", with Ethylene Propylene Diene Monomer, EPDM O-Ring Seal in each end. Fittings with the sizes of 2-1/2" and larger shall have cross-section Grab Rings and separation rings.

Manufacturer: Viega, Mueller Industries, Apollo, or equal.

PF-4b: Wrought copper - solder type ANSI B 16.22.

Manufacturer: Mueller Brass, Nibco, Lee Brass, or equal.

PF-4c: Grooved end type- ASTM B75 or B152 and ANSI B16.22 wrought copper, bronze sand casting per ASTM B584-87 copper alloy CDA 836 per ANSI B16.18. Couplings shall be CTS style 606 supplied with angle pattern bolt pads for rigidity, coated with copper coated alkyl enamel. Gaskets shall be pre-lubricated Flush seal type.

Manufacturer: Victaulic, or equal.

P-5: Copper water tube, Type K hard, ASTM B88.

Manufacturer: Mueller, Cerro Brass, Cambridge-Lee, Halstead, or equal.

P-6: Type 316L Stainless steel chemical waste pipe, marked with manufacturer's identification and fittings. Manufacturer's representative shall instruct installers and certify them for joint installation. Piping system shall be provided with a five-year manufacturer's material warranty.

Manufacturer: Blucher-Josam, Viega, or equal.

PF-6a: Type 316L Stainless Steel Mechanical joints. Stainless steel joint for chemical waste piping systems including drain or bottle traps.

Manufacturer: Blucher-Josam, or equal.

PF-6b: Type 316L Stainless Steel Press Fittings. For chemical waste piping systems including drain, vent or bottle traps, provide with EPDM seals. For compressed air piping systems, provide with HNBR seals. Manufacturer's representative shall instruct installers and certify them for joint installation.

Manufacturer: Viega, or equal.

P-7: Black steel pipe, Schedule 40, ASTM A53, Type E, ERW.

Manufacturer: US Steel, or equal.

PF-7a: Malleable iron, Class 125, ANSI B 16.3, threaded or welded Schedule 40 black steel for 2-inches and below and welded for 2 1/2-inch and above.

Manufacturer: Stockham, or equal.

- PF-7b: Grooved end type– ASTM A395 and A536 ductile iron; ASTM A234 WPB forged steel; fabricated from ASTM A53 carbon steel. Couplings shall be supplied with angle-pattern bolt pads for rigidity, except in locations where flexibility is desired. Gaskets shall be pre-lubricated.
Manufacturer: Victaulic, Galvanized or painted, or equal.
- PF-7c: MegaPressG, ASME B31, Carbon Steel, – For aboveground piping 2-inches and below. Provide fittings with Hydrogenated Nitrile Butadiene Rubber, HNBR Sealing Element.
Manufacturer: Viega, or equal.
- PF-7d: Malleable Iron, class 125, ANSI B 16.3, threaded schedule 80 black steel.
Manufacturer: Stockham, or equal.
- P-8: Red seamless brass 85-5-5-5, iron pipe size (IPS), threaded pipe, ASTM B43.
Manufacturer: Mueller, Cerro Brass, Cambridge-Lee, Halstead, or equal.
- PF-8: Bronze and brass, 250 psi, threaded, ASA B16.17 and F S WW-P-460.
Manufacturer: Mueller Brass, Lee Brass, or equal.
- P-9: PVC, thick wall, cast-iron OD sized, UL, and NSF listed, comply with AWWA C900, and ASTM D1784 Cell Class 12454B, with tracer wire.
Manufacturer: Blue Brute, or equal.
- PF-9: Ductile Iron conforming to AWWA C110, and AWWA C153, with bell and spigot gasket joints conforming to AWWA C111/A21.11.
Manufacturer: EBAA Iron Sales Inc. Megalug 2000PV, or equal.
- P-10: CPVC (Chlorinated polyvinyl Chloride) schedule 40 pipe, conforming to ASTM D1784, and UL723 (ASTM E84).
Manufacturer: Spears, Corzan, Charlotte, or equal.
- PF-10: CPVC (Chlorinated Polyvinyl Chloride) schedule 40 fittings, conforming to ASTM D1784, and UL723 (ASTM E84). The joints shall be of solvent cement type conforming to ASTM F493. Installer shall be certified by the manufacturer for this type of joint installation. Drains, bottle traps and similar devices shall be the same material and gauge as the pipe with mechanical joints.
Manufacturer: Spears, Corzan, Charlotte, or equal.
- P-11: PVDF (Polyvinylidene Fluoride) schedule 40 chemical waste pipe, conforming to ASTM F1673, ASTM D3222 and complying with UL723 (ASTM E84). The joints shall be no-hub mechanical Joints or Socket Fusion. Installer shall be certified by manufacturer for joint installation.
Manufacturer: Orion, or equal.

PF-11a: PVDF (Polyvinylidene Fluoride), schedule 40, No-hub coupling. Each coupling shall have 300 series stainless steel outer band and 5/16 inch bolts, nuts and washers plated to meet a 100-hour salt spray test per ASTM B117. Drains, bottle traps and similar devices shall be the same material and gauge as the pipe with mechanical joints. Installer shall be certified by the manufacturer for this type of joint installation.

Manufacturer: Orion, or equal.

PF-11b: PVDF (Polyvinylidene Fluoride), schedule 40 coupling. Joined using the socket fusion system conforming to ASTM 2657. Drains, bottle traps and similar devices shall be the same material and gauge as the pipe with mechanical joints. Installer shall be certified by the manufacturer for this kind of joint installation.

Manufacturer: Orion, or equal.

P-12: FRPP (Flame Retardant Polypropylene) schedule 40 chemical waste pipe, conforming to ASTM F1412 and ASTM D4101. The joints shall be no-hub mechanical joints or Socket Fusion type. Installer shall be certified by the manufacturer for joint installation.

Manufacturer: Orion, or equal.

PF-12a: FRPP (Flame Retardant Polypropylene), schedule 40, No-hub coupling. Each coupling shall have 300 series stainless steel outer band and 5/16 inch bolts, nuts and washers plated to meet a 100-hour salt spray test per ASTM B117. Drains, bottle traps and similar devices shall be the same material and gauge as the pipe with mechanical joints. Installer shall be certified by the manufacturer for this type of joint installation.

Manufacturer: Orion, or equal.

PF-12b: FRPP (Flame Retardant Polypropylene), schedule 40 coupling. Joined using the socket fusion system conforming to ASTM 2657. Drains, bottle traps and similar devices shall be the same material and gauge as the pipe with mechanical joints. Installer shall be certified by the manufacturer for this kind of joint installation.

Manufacturer: Orion, or equal.

P-13: Polyethylene plastic pipe, ASTM D 2513, Standard Dimension Ratio 11 rated at 80 psi working pressure and 73° Fahrenheit for 3 inches and smaller, SDR 11.5 rated at 76 psi and 73° Fahrenheit for 4 inches and above, butt or socket type fittings, joined by heat fusion, orange or yellow color. Installer shall be certified by the manufacturer for this kind of joint installation.

Manufacturer: CPCHEM (Chevron Phillips Chemical Company LP) PE 2406, or equal.

PF-13a: Polyethylene plastic fittings, ASTM D 3261 and D 2683, Standard Dimension Ratio 11 rated at 80 psi working pressure

and 73° Fahrenheit for 3 inches and smaller, SDR 11.5 rated at 76 psi at 73° Fahrenheit for 4 inches and above, butt or socket type fittings, joined by heat fusion, Installer shall be certified by manufacturer for joint installation. Color orange or yellow.

Manufacturer: CPCHEM, (Chevron Phillips Chemical Company LP), or equal.

PF-13b: Polyethylene transition risers, for PF-13a above, Transition fitting must have a minimum vertical height of 36 inches from the horizontal connection which will allow for a 6-inch steel riser above ground. Polyethylene transition risers shall be anodeless.

Manufacturer: Central Plastics Company, or equal.

P-14: PVC, schedule 40, extruded from 100 percent virgin Polyvinyl Chloride (PVC) compound, meeting requirements of class 1254-13 of ASTM D1784. (Use for irrigation systems after the control valves only.)

Manufacturer: Spears, Charlotte, or equal.

PF-14 Plastic fittings, schedule 40 molded from PVC type I compound, conforming to the requirements of specification ASTM D2466.

Manufacturer: Spears, Charlotte, Harvel Plastics Inc., or equal.

P-15: Purple pipe, PVC, schedule 40 for reclaimed or recycled water (below ground only for non-potable irrigation systems), type 1, grade 1, PVC-1120, Cell Class 12454 B.

Manufacturer: Charlotte, or equal.

PF-15: Purple Plastic fittings, schedule 40 molded from PVC type I compound, conforming to the requirements of specification ASTM D2466. Refer to section 32 8426 "Reclaimed Water Irrigation".

Manufacturer: Charlotte, or equal.

L. Pipe and Fitting Requirements Schedule: Unless otherwise specified or indicated on Drawings, pipe and fittings shall be installed in accordance with the following table:

TABLE I
PIPE AND FITTING SCHEDULE

Use	Limits	Pipe	Fittings
Compressed air	All sizes	P-6	PF-6
Condensate drains and drains From HVAC Equipment	All sizes	P-4, or P-6 *Roof penetration & above, and exterior exposed piping shall be P-6 only	PF-4b, or PF-6b *Roof penetration & above, and exterior exposed piping shall be P-6 only

Use	Limits	Pipe	Fittings
Domestic Cold Water, underground	Within 5' from building, All sizes	P-5	PF-4a, or PF-4b
Domestic Cold Water, underground	Site distribution only, 4" and over	P-9; Refer to 33 1100	PF-9; Refer to 33 1100
Domestic Hot and Cold water, aboveground	Interior only	P-4	PF-4a, or PF-4b
Downspouts, Interior Storm Drainage	Within 5' from building, All sizes	P-1	PF-1a, or PF-1b
Exposed Downspouts, Interior Storm Drainage	Existing Buildings and aboveground only	P-2	PF-2
Fire Mains (Fire Hydrants), Underground	Site distribution only, 4" and over	P-9; Refer to 33 1100	PF-9; Refer to 33 1100
Fire Suppression System, Interior	All sizes	P7; Refer to 21 1313	PF-7d; Refer to 21 1313
Irrigation, After Backflow Preventer	All sizes	P14; Refer to 32 8413	PF-14; Refer to 32 8413
Irrigation, Meter to Backflow Preventer	Up to 4"	P-5; Refer to 33 1100	PF-4a, or PF-4b; Refer to 33 1100
Irrigation, Meter to Backflow Preventer	4" and over	P-9; Refer to 33 1100	PF-9; Refer to 33 1100
Irrigation, Reclaimed Water or Recycled Water	All sizes	P15; Refer to 32 8426	PF-15; Refer to 32 8426
Natural Gas, Exterior	Underground, site only	P-13	PF-13a, and PF-13b
Natural Gas, Interior, aboveground	All sizes	P-7	PF-7a, PF-7b, or PF-7c
Vents-ACID,	All sizes	P-6, P-10, P-11, or P-12 *Roof penetration & above shall be P-6 only	PF-6a, PF-10, PF-11a, PF-11b, PF-12a, or PF-12b *Roof penetration & above: PF-6a only
Waste - ACID - Aboveground - Passing through Air	All sizes	P-11	PF-11a, or 11b

Use	Limits	Pipe	Fittings
Plenum			
Waste - ACID - Aboveground - Fire-Rated	All sizes	P-12	PF-12a, or 12b
Waste - ACID - Aboveground	All sizes	P-10	PF-10
Waste - ACID - Underground	All sizes	P-6	PF-6a, or 6b
Waste - FORCED	All sizes	P-1	PF-1c
Waste and Vent - Indirect	All sizes	P-3	PF-3
Waste and Vent – Sanitary/ Grease	All sizes	P-1	PF-1a, or 1b
Waste and Vent – Sanitary/ Grease	Underground, site only	P-1; Refer to 33 3000	PF-1a, or 1b; Refer to 33 3000

M. Pipe Isolators:

PLA-1 Absorption pad shall be not less than ½ inch thick, unloaded. Pad shall completely encompass pipe.

Manufacturer: Holdrite, LSP, Stoneman, Potter-Roemer, Trisolator, PR-Isolator, or equal.

Manufacturer: Hydra-Zorb Cushion Clamps, Acousto-Clamp, or equal.

N. Pressure Gage: Aluminum or steel case, minimum 4 ¼-inch dial; pressure type or combination vacuum-pressure type, with provisions for field calibration. Dial indicator to indicate pressure in psi with accuracy to within plus or minus 0.5 percent of maximum dial reading. Furnish gages with restriction screw, size 60, to eliminate vibration impulses. Black case and ring, bourdon tube of seamless copper alloy with brass tip and socket. Three way gage cock, constructed of brass with stuffing box, 1/2 inch couplings, with fixed or movable cap nut to shut off pressure gage.

PG-1 Pressure type, black drawn steel case, 4-1/2-inch glass dial, range approximately twice line pressure.

Manufacturer: Marsh Keckley, Trerice, Weksler, Weiss, or equal.

O. Plug Valves:

PV-1 2 inches and smaller: Rockwell No.114, lubricated plug type, 200-pound., water operating gauge pressure iron body and plug, regular pattern, threaded, with indicating arc.

Manufacturer: Walworth, Homestead, WKM, or equal.

PV-2. 2 ½-inch and larger: Rockwell No.115 and No.165 lubricated plug type, 200 pound water operating gauge. Iron body and plug, regular pattern, flanged, with indicating arc.

Manufacturer: Walworth, Homestead, WKM, or equal.

P. Safety Relief Valves:

SRV-1: Combination temperature and pressure relief type. CSA approved. Set to open at 125 psi pressure.

Manufacturer: Watts: 40L, Cash-Acme: NCLX-1, or equal.

SRV-2: Same as SRV-1, except provide on storage type water heater with anode in dip tube.

Manufacturer: Watts: 100XL, Cash-Acme: NCLX-1, or equal.

SRV-3 Spring type, ASME and NB stamped and certified with manual lifting device for air or gas.

Manufacturer: Bailey, Cash-Acme, Watts, Keckley, or equal.

Q. Strainers:

STR-1 Description: Wye type with monel or stainless steel strainer cylinder (manufacturer's standard mesh), and gasketed machine strainer cap. Where indicated on Drawings, provide with valved (globe valve) blowout piping, same size as blowout plug.

1. 2-inch and smaller:
C.M. Bailey No.100-A, 250 lb., cast iron body, threaded, Keckley: Style B, Spirax Sarco Y-type, or equal.

2. 2 ½-inch and larger:
C.M. Bailey No.100-A, 125 lb., cast iron body, flanged, or Victaulic style 732, 300 psi, ductile iron body, grooved, fusion bonded epoxy coated.

Manufacturer: C.M.Bailey, Armstrong, Muessco, Keckley 'A', or equal.

STR-2 Y pattern cast iron bodies, 125 psi, monel screen. Open area at least twice the cross-sectional area of IPS pipe in which strainer is installed and may be woven wire or perforated type. Screwed ends for sizes up to 2 inches, flanged ends fusion bonded epoxy coated for 2 ½-inch and larger perforations, in accordance with the following:

1. Steam service - 40 square mesh.

2. Other services - 16 square mesh.

Bailey No.100, Armstrong, RP&C, Keckley or equal.

STR-3 Flanged, bucket type, semi-steel body, 125 psi, stainless steel screen with 1/8 inch diameter perforations, all sizes.

Manufacturer: Bailey No.1, Zurn 150 Series, RP&C, Keckley GFV, or equal.

STR-4 Grooved, T-pattern, ductile iron body, 300 psi, stainless steel frame and mesh basket, grooved ends.

R. Vent Caps:

VC-1 Vandal-proof hood type, for plumbing vent lines.

Manufacturer: Stoneman Engineering and Mfg., Semco 1550, or equal.

S. Vacuum Valves:

VV-1 Vacuum valves; for vacuum serve, 125 psig working pressure, cast iron body, spring loaded lubricated plug type.

Manufacturer: General Controls, Honeywell, Valmatic, or equal.

T. Protective Coating for Underground Steel Piping Applied to Underground Automotive:

1. Black steel or galvanized steel piping indicated for below grade installation, shall be protected as specified prior to delivery to the Project site:
 - a. Sandblast black steel pipe to a gray finish. Sandblast galvanized steel pipe lightly only.
 - b. Install one coat of cut back asphalt to galvanized pipe immediately after sandblasting. Pre-heat black pipe to 180 degrees F. immediately before coating.
 - c. Install one coat of high-temperature (melting point of 240 degrees F. minimum) Grade B asphalt enamel.
 - d. Install one wrapping of 20 mils thick glass, fiber mat, Owens-Corning Coromat or L.O.F. Blueflag with 1/4 inch overwrap. Glass fiber shall be dry at time of installation.
 - e. Install a second coat of asphalt enamel as specified above. Glass fiber mat shall be centered in the asphalt enamel.
 - f. Install an overwrap of Kraft ripple paper.
2. Total thickness of pipe wrapping shall be not less than 1/8 inch. Entire coating operation shall be accomplished by mechanical means in a continuous operation. Hand installation of protective coating is not permitted.
3. Each piece of wrapped pipe shall be legibly identified at no greater than 5 feet intervals by fabrication company. Each material submittal shall include the name of the fabrication company. Maintain one reviewed Sample on the Project Site.

4. Acceptable manufacturers of wrapping are: Hunt, Mobile, Conway or equal.
5. Fittings (including couplings), unprotected pipe adjacent to fittings, and damaged pipe protection shall be wrapped at Project site as follows:
 - a. Fittings and pipe to be wrapped shall be thoroughly cleaned of material foreign to pipe manufacturer.
 - b. Install one coat of Plicoflex No. 105 or Protecto Wrap No. 1170 adhesive primer to metal.
 - c. Wrap pipe and fittings with a minimum thickness of 3/32 inch of Plicoflex No. 310 pipe line butyl molding tape, or Protecto Wrap No. 200 molding tape. Install 3 layers, each layer overlapping next approximately 2/3 width of tape, without stretching. Tape and primer shall be of the same manufacturer.
 - d. Wrap vinyl tape, 10 mil thickness, over molding tape with 1 inch minimum overlap.

Manufacturer: J.M. Trantex, 3M Scotchwrap or equal.
5. Pipe and fittings specified to be wrapped shall be tested with a holiday detector, after pipe has been installed in trench and before backfilling, in presence of the Project Inspector. Furnish a Tinkler and Raser model E-P holiday detector, or similar equipment for this test. Work, which is deemed defective, shall be repaired or replaced. The Project Inspector may test for damaged pipe wrapping after backfilling.
6. Instead of wrapping underground steel pipe as specified above, pipe may be machine-wrapped before delivery to the Project site as follows:
 - a. Pipe shall be cleaned of moisture, oil, grease, scale, and other foreign material by cleaning with non-oily solvent and wire brushing. Remove metal burrs and projections.
 - b. Install one coat of Plicoflex No.105 adhesive primer to cleaned pipe. If thinning is required, furnish only non-oily thinners as recommended by tape manufacturer.
 - c. Wrap coated pipe with Plicoflex No.340-25 tape (15 mil butyl and 10 mil vinyl laminate) Tape shall be installed by machine wrapping at approved plant only. Maintain tension (minimum of 5 pounds per inch of width) on tape over entire diameter of pipe. Tape shall be permanently identified and visible on vinyl side.
 - d. Fittings, unprotected pipe, and damaged pipe protection shall be wrapped as indicated above.

- U. Flanges: Flanges shall be furnished and installed at each flanged connection of each type of equipment, tanks, and valves. Faces of flanges being connected shall be furnished alike. Connection of a raised face flange to a flat-faced flange is not permitted. Flanges shall conform to following schedules:

TYPE OF PIPE	FLANGE
Screwed black or galvanized grooved steel pipelines.	125-pound black cast iron screwed flange, flat faced or grooved flange adapters, Victaulic Style 741, Tyco-Grinnell Fig. 71, Gruvlok Fig. 7401, or equal.
Welded or grooved steel pipe, except high pressure steam lines.	150-pound black forged steel welding flanges, 1/16 inch raised face ASTM A 105, Grade II or grooved flange adapters, Victaulic Style 741, Tyco-Grinnell Fig. 71, Gruvlok Fig. 7401, or equal.
Copper and brass pipe or tubing.	150 pound cast bronze, flat-faced flange with solder end or grooved flange adapters, Victaulic Style 641, Tyco-Grinnell Fig. 61, Gruvlok Fig. 6084, or equal.

1. Gasket material for flanged connections shall be full faced or ring type to suit facing on flanges and shall be furnished in accordance with following schedule:

SERVICE	TYPE
Cold water	1/16-inch-thick neoprene

Grooved end flange adapters supplied with pressure responsive elastomeric Gaskets supplied with grooved flange adapters shall be pre-lubricated by the manufacturer. Grade of gasket to suit intended service.

V. Unions:

1. Unions shall be furnished and installed in accordance with the following requirements (unless flanges are furnished):
 - a. At each threaded or soldered connection to equipment and tanks, except in Freon or fuel gas, piping systems, whether indicated or not.
 - b. Immediately downstream of any threaded connection to each manually operated threaded valve or cock, and each threaded check valve, yard box or access box except those in Freon piping systems, whether indicated or not.
 - c. At each threaded connection to threaded automatic valves (except those in Freon piping systems) such as reducing valves and temperature control valves, whether indicated or not.
 - d. If grooved piping is used, couplings shall serve as unions. Additional unions are not required
2. Unions shall be located so that piping can be easily disconnected for removal of equipment, tank, or valve.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which Work of this Section shall be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Provide all materials and equipment for the Work. Furnish and install necessary apparatus, parts, materials, and accessories.
- B. Pipe Installation:
 - 1. Install piping parallel to wall and provide an orderly grouping of proper materials and execution.
 - 2. Piping shall clear obstructions, preserve headroom, provide openings and passageways clear, whether indicated or not. Verify the Work of other Divisions to avoid interference.
 - 3. If obstructions or the Work of other Divisions prevent installation of piping or equipment as indicated by the Drawings, perform minor deviations as required by the ARCHITECT.
 - 4. Install piping after excavation or cutting has been performed. Piping shall not be permanently enclosed, furred in, or covered before required inspection and testing is performed.
 - 5. Exposed polished or enameled connections from fixtures or equipment shall be installed with no resulting tool marks or threads at fittings. Residue or exposed pipe compound shall be removed from exterior of pipe.
 - 6. Piping shall be concealed in chases, partitions, walls, and between floors, unless otherwise directed or specifically noted on Drawings. When penetrating wood studs, joists, and other wood members, provide such members with reinforcement steel straps of Continental Steel & Tube Co., ULINE, Independent Metal Strap, or equal.
 - 7. Reduce fitting where any change in pipe size occurs. Bushings shall not be furnished unless specifically reviewed by the ARCHITECT, or indicated on Drawings.
 - 8. Piping subject to expansion or contraction shall be anchored in a manner, which permits strains to be evenly distributed. Swing joints or expansion loops shall be installed. Seismic restraints shall be installed so as not to interfere with expansion and contraction of piping. Seismic loops required at all building separations.

9. Immediately after lines have been installed, openings shall be capped or plugged to prevent entrance of foreign materials. Caps shall be left in place until removal is necessary for completion of installation.
10. Couplings shall not be installed except where required pipe runs between other fittings are longer than standard length of type of pipe being installed and except where their installation is specifically reviewed by the ARCHITECT.
11. Water piping shall be installed generally level, free of traps, unnecessary offset, arranged to conform to building requirements, clear of ducts, flues, conduits, and other Work. Piping shall be arranged with valves installed to provide for complete drainage and control of system. Piping shall not be installed which causes an objectionable noise from flow of water therein under normal conditions. Refer to Section 23 0500: Common Work Results for Plumbing.
12. Water lines may be installed in same trench with sewer lines, provided bottom of water line is 12 inches minimum above top and to the side of sewer line.
13. Changes in pipe sizes shall be furnished with eccentric reducers, flat on top. Offsets to clear obstruction shall not be installed so as to produce air pockets.

C. Pipe Sleeves and Plates:

1. Provide pipe sleeves of Schedule 40 black steel pipe or Schedule 40 PVC plastic pipe in concrete or masonry walls, footings, and concrete floors below grade. Provide adjustable submerged deck type sleeves at locations where pipes pass through concrete floors, except concrete slab floors on grade, and at locations where soil pipe for floor type water closets passes through concrete floors.
2. Sleeves shall provide ½ inch clearance around pipes, except plastic pipe shall have 1 inch clearance. Caps of deck type sleeves shall be removed just prior to installation of pipe. Area around sleeves shall be smooth and without high or low spots. Sleeves in walls shall not extend beyond exposed surface of wall. Sleeves in concrete floors and walls shall be securely fastened to forms to prevent movement while concrete is being placed.
3. Piping installed on a roof shall clear the roof surface by 10 inches minimum, with or without insulation. Bottom of individual fittings may infringe on 10 inches clear space but not groups of fittings or fittings located within 27 inches of each other.
4. Stiles shall be provided to facilitate crossing of piping when parallel piping runs are laterally greater than 12 inches out-to-out, or any pipe is higher than 18 inches, and more than 40 feet long or runs between two or more major pieces of equipment or housings greater than 20 feet apart. Stiles shall be not less than 20 inches wide with a minimum tread depth of 10 inches. Where stiles are required, they shall be located so greatest obstructed distance is 30 feet.

5. Where pipes pass through waterproofed walls, floors, or floors on grade, sealant with Link-Seal Modular Seals, or equal, between pipe and sleeve to provide a waterproof joint. Where earth is in contact with pipe on both sides of a wall or foundation, the waterproof joint is not required. Commercial rubber compression units may be furnished instead of sealed sleeves if reviewed by the ARCHITECT.
6. A swing joint, or other required device, shall be furnished and installed in hot water lines with 10 feet of sealant or compression joint to allow for expansion.
7. Provide polished, chrome-plated flanges when plumbing pipes pass through walls at plumbing fixtures, etcetera as specified in Section 22 4000 Plumbing. Provide polished steel, chromium-plated split floor and ceiling plates at locations where pipes pass through walls, floors, ceilings, and partitions in finished portion that neatly conceals pipe insert.
8. Pipe sleeves shall be provided where pipes intersect footings or foundation walls and sleeve clearances shall provide for footing settlement, but not less than one inch all around pipe.

D. Welding of Pipe and Qualifications of Welder:

1. Joints above grade or accessible conduit or tunnels in steel piping may be either welded or screwed unless specifically indicated otherwise on Drawings or specified. Joints in below grade steel piping, whether in insulation or not, shall not be welded, unless otherwise indicated.
2. Welded joints in pipe shall be continuous around pipe and shall comply with ASME B31: Code for Pressure Piping, unless otherwise specified.
3. Each pipe weld shall be stamped with welder's identification mark. Welding shall be performed by welders possessing a valid certificate of qualification for welding carbon steel welding pipe in horizontal position (2G) and horizontal fixed position (5G) in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code, by an OWNER-recognized, DSA approved testing laboratory.
4. Before any welder performs welding on the Work, furnish the INSPECTOR with a copy of welder's valid qualification papers and obtain verification. Welder qualification is not valid unless it has been issued while welder was performing work for current employer, and has performed type of work described by qualification in the preceding 3 months.
5. Welding performed under these Specifications is subject to special tests and inspections including rigid Ultra Sonic Testing (UT) and radiographic inspection at random, in accordance with Technique for Radiographic Examination of Welded Joints by an OWNER recognized, DSA approved testing laboratory.

E. Unacceptable Welds and Repairs to Welding:

1. Welds containing any of the following types of imperfections shall be deemed defective Work:

- a. Cracks of any type.
 - b. Zones of incomplete (in excess of 1/32 inch) fusion or penetration.
 - c. Elongated slab inclusions longer than 1/4 inch.
 - d. Groups of slag inclusions in welds having an aggregate length greater than thickness of parent metal in a length 12 times the thickness of the parent metal.
 - e. Undercuts greater than 1/32 inch.
 - f. Overlaps, abrupt ridges or valleys.
3. When a defective weld is detected by examination as outlined above, two additional welds shall be radiographed at locations selected by the Project Inspector. If the two selected welds demonstrate compliant welding, then the two tested welds shall be deemed to be in compliance. Welding revealed by radiographs to be defective Work shall be removed, repaired, and tested by radiograph.
 4. If either of the two selected welds demonstrates welding deemed to be defective Work, all welding in that portion of the Work shall be deemed defective Work and either: all welds shall be cutout, prepare new ends for welding and weld to comply with this Specification, or radiograph all welds, removing and repairing only such welding deemed to be defective Work.
 5. Repair welding shall be performed in a manner in full compliance with ASME B31. The welded joints or repairs shall be spot examined with UT or radiographic tests in accordance with foregoing requirements.
 6. OWNER shall cause to be performed additional random UT and radiographic examinations of welds. OWNER shall be responsible for the costs of any UT and radiographic examinations found to be in compliance with specified requirements.
 7. Installer shall be responsible for the costs of UT and radiographic re-examinations of welds deemed defective Work and not in compliance with this Specification, and shall repair or replace said welds in accordance with specified requirements.
- F. Welding Rods: Submit a written list of materials and proposed type of welding rods.
- G. Backing Rings: Backing rings may be submitted for installation provided the Product Data is submitted with the material list.
- H. Qualification Tests for Low-pressure Welding:
1. Tests shall be performed on 3-inch standard weight pipe ASTM A53, Grade A, and shall be welded by acetylene and electric arc. Each sample

shall consist of 2 pieces, each 10 inches long, with 30-degree bevel at point weld.

2. Two 20-inch samples shall be performed in the 2G and two 20-inch samples in the 5G positions, with positions defined in Section IX, ASME Boiler and Pressure Vessel Code. Welds shall have the reinforcement ground or machined flush to the surface of the pipe before testing. Samples shall be tested as full section tensile.
3. Weld shall develop a load of 90 percent of 50,000 psi, i.e., 45,000 psi or shall develop a fracture in parent metal.
4. Each qualified welder shall carry an identification card listing welder's name, date of test, and type of welding tests passed; signed by the welder and the laboratory.
5. A valid certificate of qualification issued in compliance with requirements of the ASME Boiler Pressure Vessel Code Section IX shall qualify a welder for issuance of a certificate for low-pressure pipe welding.

I. Certificates of Qualification for Welding of Unfired Pressure Vessels:

1. Certificates of qualification shall be issued by a laboratory recognized by the OWNER in compliance with the requirements of the ASME Boiler Pressure Vessel Code Section IX. Qualifications shall be for both acetylene and arc welding of Schedule 40 ASTM A53, Type B, steel welded or seamless pipe in the Horizontal Position (2G) and the Horizontal Fixed Position (5G) as defined by said code.
2. Certificate described above is not valid unless it has been issued while welder was working for his current employer, and unless welder has performed type of work described by certificate in the preceding three months. Requirements for possession of a valid certificate shall not be waived for welders fabricating unfired pressure vessels when the Specifications require compliance with ASME code or when welding pipe carries working pressures greater than 75 psi and temperatures greater than 250 degrees F.

J. Pipe Joints and Connections:

1. Pipe and tubing shall be cut per IAPMO Installation Standards. Pipe shall have rough edges or burrs removed so that a smooth and unobstructed flow shall be provided.
2. Hot tapping of gas lines is strictly prohibited.
3. Threaded Pipe: Joints in piping shall be installed according to the following service schedule:
 - a. Soap Piping: Litharge and glycerine, or Expando, Gasoila, or equal.
 - b. Plastic Piping: Teflon pipe joint compound tape.

- c. Oxygen Piping: Wash threads with S.P., rinse, blow-dry and apply litharge and glycerine.
 - d. Cleanout Plugs: No compound shall be used. After inspection and test, plugs shall be removed, cleaned, greased, and replaced.
 - e. Other services furnish sealant, suitable and as reviewed by the ARCHITECT.
- 4. Threads on pipe shall be cut with sharp, clean, unblemished dies and shall conform to ANSI/ASME B2.1 for tapered pipe threads.
 - 5. Joint compounds shall be smoothly placed on male thread and not in fittings. Threaded joints shall be installed tight with tongs or wrenches and sealant of any kind is not permitted. Failed joints shall be replaced with new materials. Installation of thread cement or sealant to repair a leaking joint is not permitted.
 - 6. Sharp-toothed Stillson, or similar wrenches, is not permitted for the installation of brass pipe or other piping with similar finished surfaces.
- K. Copper Tubing and Brass Pipe with Threadless Fittings:
- 1. Silver brazed joints shall be used for attaching fittings to non-ferrous metallic refrigerant piping.
 - 2. Non-pressure gravity fed condensate lines may be soldered with 95/5 solder.
 - 3. Silver brazing alloy, Class BCUP-5. Surfaces to be joined shall be free of oil, grease, and oxides. Socket of fitting and end of pipe shall be thoroughly cleaned with emery cloth and wiped to remove oxides. After cleaning and before assembly or heating, flux shall be installed to each joint surface and spread evenly. Heat shall be applied in accordance with instructions in the Copper Tube Handbook issued by Copper Development Associates. Joints constructed of rough bronze fittings shall be provided as recommended by manufacturer.
 - 4. Do not overheat piping and fittings when installing silver brazing.
 - 5. Joints in non-ferrous piping for services not covered above shall be installed with solder composed of 95/5 tin/antimony, ASTM B32, Grade 5A. Surfaces to be jointed shall be free of oil, grease, and oxides. Sockets of fitting and end of pipe shall be cleaned with emery cloth to remove oxides. Solder flux shall be sparingly installed and solder added until joint is completely filled. Do not overheat. Excess solder, while plastic, shall be removed with a small brush in order to provide an uninterrupted fillet completely around joint. Random inspection of joints shall be conducted by Project Inspector to ensure joints are lead-free.
 - 6. Grooved end joints for copper piping shall be assembled in accordance with the latest manufacturer recommendations. Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from

pipe end to groove for proper gasket sealing. Grooving tools shall be as manufactured by Victaulic, RIDGID, MAG Tool, or equal.

7. Pressed fittings for copper or copper alloy pipe or tubing shall have an elastomeric O-ring that forms the joint. The pipe or tubing shall be fully inserted into the fitting, and the pipe or tubing marked at the shoulder of the fitting. Pipe or tubing shall be cut square, mechanically cleaned and reamed prior to joining to remove all burrs (interior and exterior) and restore full inside diameter and a smooth, chamfered exterior surface. The fitting alignment shall be checked against the mark on the pipe or tubing to ensure the pipe or tubing is inserted into the fitting. The joint shall be pressed using the tool recommended by the manufacturer.
- L. Ring-Type Pipe: Joints shall be installed in accordance with manufacturer's instructions with grooved couplings, fittings and rubber rings. Couplings and pipe shall be compatible and of the same manufacturer. Rings shall be accurately located and installed by grooves in coupling. Pipe shall be installed with zero deflection unless otherwise specified. Pressure pipe shall be furnished with thrust blocks at each offset point.
- M. Welded Pipe Joints:
 1. Joints in welded steel pipelines shall be installed by oxyacetylene or electric arc process. Welding shall be continuous around pipe and provided as specified.
 2. Butt welds shall be of the single V-type, with ends of pipe and fittings beveled approximately 37 ½ degrees. Piping shall be aligned before welding is started with the alignment maintained during welding.
 3. Welds for flanges and socket fittings shall be of the fillet type with a throat dimension not less than pipe wall thickness.
- N. Grooved End Pipe Joints: Grooved end joints for carbon steel piping shall be assembled in accordance with the latest manufacturer recommendations. Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. Grooving tools shall be as manufactured by Victaulic, RIDGID, MAG Tool, or equal.
- O. Joints shall be Vic-Press 304TM, or equal, made with Victaulic Series 'PFT' tools and the appropriate sized jaw. Pipe shall be certified for use with Vic-Press 304TM system, and shall be square cut, properly deburred and cleaned, and marked at the required location to insure full insertion into the fittings and/or couplings.
- P. Polyethylene (Plastic) Pipe:
 1. Joints shall be installed by the heat fusion method, in accordance with manufacturer's recommendations and IAPMO installation standard IS 12, for natural gas.
 2. Pipe Riser at Meter, Regulator and Building Wall: Prefabricated, anodeless type, utilizing a grade level transition between underground polyethylene pipe and gas supply steel pipe of riser outlet, R. W. Lyall

Co., or equal. Below grade to above grade transition shall be installed in a welded, epoxy coated, steel casing.

3. Connections to Existing Pipe Line or Branch:

- a. Steel-to-plastic (PE): Provide manufacturer's prefabricated standard transition fitting, transition from epoxy-coated steel pipe to plastic, R. W. Lyall Co., or equal.
- b. Plastic-to-plastic, PVC to PE: Provide manufacturer's prefabricated standard transition fitting, transition from PVC to epoxy-coated steel pipe to PE; R.W. Lyall Co., or equal.
- c. Plastic-to-plastic, PE to PE: Provide manufacturer's standard fused tapping tee assembly with shut-off feature.

4. Provide PE reinforcing sleeves where PE pipe is fused to multi-saddles, service punch tee, reducing tees, transition fittings and anodeless risers.

Q. Valves: Valves shall conform to the following:

1. Piping systems shall be furnished with valves at points indicated on Drawings and specified, arranged to provide complete regulating control of piping system throughout building and the Project site.
2. Valves shall be installed in a neat grouping, so that parts are easily accessible and maintained.
3. Valves shall be full size of line in which they are installed, unless otherwise indicated on Drawings or otherwise specified, and shall be one of types specified.
4. Provide chain operators on valves 2-inch and larger located 7 feet or more above the servicing floor level.
5. Valves for similar service shall be of one manufacturer.
6. Except where otherwise specified, valves shall be Belimo, Victaulic, Stockham, Crane, Jenkins, Milwaukee, Hammond, American, NIBCO, Hoffman, or equal.
7. Ball valves below grade in yard boxes shall have stainless steel handles.
8. Hose bibs in dense garden areas shall be $\frac{3}{4}$ inch in size with one hose bib in the lunch pavilion 1 inch in size. Other hose bibs shall be $\frac{3}{4}$ inch lock shield type. Bibs shall be furnished with vacuum breaker protection.
9. Safety valves and pressure relief valves shall have stamp of approval as required by ASME and shall be provided with annual test lever. Where a hot water storage tank is heated by means of a coil, pressure relief valve shall have a steam BTU discharge rating of the coil. Discharge pipe from safety or pressure relief valves shall be not less than one pipe size larger than inlet pipe size of valve. Discharge pipe shall terminate as indicated

and shall be free of traps. In addition to locations specified, pressure relief valves shall be installed in the following locations:

- a. On discharge side of each pressure-reducing valve.
 - b. On each water heater connected to a hot water storage tank and other pressure vessels.
 - c. On cold water line to each water heater or hot water storage tank when there is a check valve, backflow prevention valve or similar device between water heater or hot water storage tank and meter or relief valve at the pressure reducing valve assembly.
 - d. On discharge side of each air compressor.
 - e. On each air receiver connected to an air compressor.
10. Temperature relief valves and combination temperature and pressure relief valves shall be as specified and furnished as set forth in this Section. Discharge pipe from relief valves shall be not less than discharge area of valve or valves it connects, based on discharge area of valves, and shall terminate as indicated and free of any traps. Valves shall be installed at following locations:
11. A combination temperature and pressure relief valve or combination of valves on each heating hot water storage tank. Temperature sending element shall extend into water inside tank.
12. Manual air vent valve assemblies shall be installed at each high point of hot water space heating and chilled water piping systems. Valves shall discharge through 1/4 inch diameter copper tubing and drain to nearest floor sink. Automatic type air vent valve shall only be installed where specifically indicated. Radiator, convectors, and finned pipe convectors shall be fitted with packless radiator valves, angle or straight pattern. Each convector or radiator installed as part of a space hot water heating system shall be furnished with a manual-type air vent valve.
- R. Strainers: Strainers shall be installed on each water main (except for fire line) downstream of the meter, above grade, when a pressure regulator assembly is not installed. Main strainer shall be of Y-flange or groove type. On closed loop chilled and heating hot water systems pump systems, a strainer shall be installed at each pump inlet and upstream of each flow control valve assembly. The control valve assembly may include a modulating temperature control valve and a flow-limiting valve, manufactured by Griswold, AutoFlow, Flow Control Industries, Inc., or equal.
- S. Hangers and Supports:
1. Piping shall be securely fastened to building structure by approved iron hangers, supports, guides, anchors, and sway braces to maintain pipe alignment to prevent sagging and to prevent noise or excessive strain on piping due to uncontrolled or seismic movement under operating conditions. Hangers and supports shall conform to Manufacturer's Standardization Society Specification SP-69. Hangers shall be relocated

as required to correct unsatisfactory conditions that may become evident when system is placed into operation. Appliances, heat exchangers, storage tanks, and similar equipment shall be securely fastened to structure in accordance with seismic requirements. Outdoor metal hangers and supports shall be hot-dipped galvanized steel, unless otherwise specified.

2. Hose faucets, compressed air outlets, and similar items at ends of pipe branches shall be rigidly fastened to building construction near point of connection.
3. Piping shall not be supported by wire, rope, wood, plumbers' tape, or other non-recognized devices.
4. Hangers and supports shall be designed to support weight of pipe, fittings, weight of fluid and weight of pipe insulation, and shall have a minimum factor of safety of five, based on ultimate tensile strength of material installed.
5. Burning or welding of any structural member under load is not permitted. Field welding not specified on Drawings or reviewed Shop Drawings is not permitted without review by ARCHITECT and DSA.
6. Burning holes in beam flanges or other structural members is not permitted without review by the ARCHITECT and DSA.
7. Pipe hangers on piping covered with low temperature insulation shall be installed on outside of insulation and not in contact with pipe unless otherwise detailed on Drawings. Insulation shall be protected by 18 gage galvanized steel shield, with a minimum length of 10 inches, installed completely around pipe covering between covering and hanger. Installing hangers directly on pipe and butting adjoining sections of insulation against hanger is permitted provided void and hanger rod are properly insulated and sealed so that no sweating occurs at hangers.
8. Hanger rods shall be fastened to structural steel members with suitable beam clamps. Clamps shall be Tolco, Carpenter & Patterson, Fee and Mason, or equal, as follows:
 - a. Tolco I beam, Fig.62 for maximum 1000 pounds.
 - b. Tolco I or WF beam, Fig. 329, for maximum of 1290 pounds.
9. Hanger rods shall be fastened to concrete inserts in concrete slabs or beams. Inserts shall be Tolco, Carpenter & Patterson, Fee and Mason, or equal, as follows:
 - a. Tolco Fig.310 for maximum of 600 pounds.
 - b. Tolco Fig. 309 for maximum of 1140 pounds.
10. For fastening to wood ceilings, beams, or joists, furnish Grinnell Fig. 128R, Grinnell Fig. 153, Tolco 78, or equal pipe hanger flange fastened with drive screws. Under wood floors, 3/8 inch hanger rods shall be hung

from 2-inch by 2-inch by 1/4 inch angle clips 3 inches long, with 2, staggered 10d nails, clinched over joist.

11. Hanger rod sizes for copper, iron, or steel pipe: 3/8 inch for pipe sizes 1/2 inch through 2-inch, 1/2 inch for pipe sizes 3-inch, 4-inch and 5-inch, 5/8 inch for pipe size 6-inch, and 3/4 inch for 8-inch and 10-inch pipe.
12. Turnbuckles, if furnished, shall provide a load carrying capacity equal to that of the pipe hanger with which they are being installed.
13. Pipe hangers shall be of same size, or nearest larger manufactured size available, as pipe or tubing on which they are being installed.
14. Hangers, clamps, and guides furnished for support of non-metallic pipe shall be padded with 1/8 inch thick rubber, neoprene, or soft resilient cloth.
15. Where special pipe-supporting requirements in the Specifications conflict with any standard requirements specified herein, the Specification requirements shall govern.
16. Vertical Piping:
 - a. Vertical pipe risers shall be securely supported with riser clamps of recognized type. Risers in reinforced concrete buildings shall be furnished with extension clamps fastened to pipe above each concrete floor slab with extended arms of clamp to rest on slab. Clamps shall be provided with lead or Teflon liners when installed on copper tubing. Clamps shall be plastic-coated when installed on non-ferrous pipe or tubing.
 - b. Copper tubing in sizes 1 1/2-inches and larger and steel pipelines passing up through building shall be supported at each floor of building or every 15 feet whichever is less.
 - c. Copper tubing sizes 1 1/4-inches and smaller shall be supported at not intervals not more than 6 feet on center. Special provisions shall be installed for vertical lines subject to expansion and contraction caused by operating temperature differences.
 - d. Vertical cast iron pipelines shall be supported from each floor and at its base. Malleable iron or steel pipe clamps with minimum thickness of 1/4 inch shall be furnished and fastened around pipe for support.
17. Horizontal Piping:
 - a. Roof Mounted Piping: Pressure and non-pressure piping shall be supported from channels, stands, clamps, trapezes, rollers, or structures mounted on 100% rubber, UV resistant rooftop supports with reflective strips, Dura-Block, or equal. Roller type supports shall be provided below and above pipe to prevent its dislodgement. Bottom of pipes shall clear the roof surface by 10 inches.

- b. Insulated steam and space heating hot water insulated condensate lines, insulated domestic hot water supply and return piping shall be supported with Tolco Figure 4, B-Line Figure B3140, Grinnell Figure 212, or equal, steel hangers with welded eye rods to permit hinge movement at point of attachment of hangers. Hinge movement at point of support shall be provided by welded eye linked rods Tolco Figure 101L, B-Line Figure B3211X, Grinnell Figure 278, or equal.
 - c. Domestic cold water piping, water supply and return piping, condenser water piping, insulated refrigerant piping gas piping, compressed air piping, cast iron soil piping, galvanized steel vents, waste and downspout piping and glass to be supported with Tolco Figure 1, B-Line Figure B3100, Grinnell Figure 260, or equal, hangers with rods, turnbuckles and inserts suitable for above hangers.
 - d. Maximum hanger and support spacing shall conform to CPC schedule for horizontal piping installed above grade.
- 18. A hanger or support shall be installed close to the point of change in direction of a pipe run, in either a horizontal or vertical plane.
 - 19. When practicable, supports and hangers for cast iron soil pipe shall be installed as close as possible to joints and when hangers or supports are not located within one foot of a branch line fitting, an additional hanger or support shall be installed at fitting.
 - 20. In systems where grooved piping is used, couplings shall be provided with angle pattern bolt pads to comply with support and hanging requirements of ANSI/ASME B31.1, ANSI/ASME B31.9, and NFPA Pamphlet 13.

T. Flashings:

- 1. Each pipe, duct, or gas-fired equipment vent passing through roof shall be installed with waterproof flashing.
- 2. Flashing or flanges on pipes, vents, and ducts passing through a tile or slate roof shall be constructed of sheet lead. Flashing for pipes and heater vents passing through a roof shall be 4 pound soft sheet lead. Flashing and flanges for ducts and heater vents passing through exterior walls shall be 22 gage sheet metal. Install caps on top of heater pipes. Flanges and flashing shall be installed waterproof at point of connection with pipe or duct. No soldered joints on roof flashings will be allowed. No Stoneman lead roof flashings will be allowed.3. Lead flashing and flanges shall be constructed of 4 pound sheet lead with burned joints. Flange of lead flashing or lead flange on a duct shall extend out onto roof a minimum of 12 inches from pipe or duct. Lead flashing shall extend up the pipe or duct not less than 8 inches.
- 3. Sheet metal flashing shall be constructed of 24 gage galvanized sheet steel. Flanges on these flashings shall extend out onto roof a minimum of 10 inches from pipe or duct. Flanges on ducts through exterior walls shall extend out from duct a minimum of 2 ½ inches. Flanges on gas-fired

equipment single-wall vents shall be of ventilated type. Type B gas vents through a roof shall be furnished with non-ventilated flashing as per NFPA Pamphlet 211.

4. Cast iron, steel, brass, and copper pipe, which terminates less than 18 inches above roof, shall be furnished with a combination counter-flashing and vandal-proof hood for protection against water, birds and foreign matter. Cast iron, steel, brass and copper pipe, which does not terminate within 18 inches of roof, shall be furnished with a counter-flashing sleeve. Pipe, which terminates more than 18 inches above roof, shall be furnished with protection against entrance of water, birds, and foreign matter.
 5. Counter-flashing and combination counter-flashing sleeves and vandal-proof hoods shall be cast iron, vandal-proof, threaded, sealed or approved gas-heated sleeve type. Counter-flashing sleeves on each of these items shall extend down over flashing a minimum of $\frac{3}{4}$ inch.
 6. Flashing and flanges on ducts shall be installed waterproof at point of connection to the duct by riveting and soldering. Storm collars shall be securely screwed and installed waterproof around appliance vent pipe immediately above flashing.
 7. Vent piping above roof shall be furnished with a combination counter-flashing sleeve and vandal-proof hood.
- U. Equipment Installation: Install roof or floor mounted equipment on level platforms, housekeeping pads or curbs and provide sound, vibration and seismic control measures per Section 23 0548 even if not indicated on Drawings.

END OF SECTION

**SECTION 22 0553
PLUMBING IDENTIFICATION**

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Marking and identification on mechanical piping systems, ducts, controls, valves, and apparatus.
- B. Related Requirements:
 - 1. Division 01: General Requirements
 - 2. Section 21 1313: Fire-Suppression Sprinkler Systems.
 - 3. Section 22 0513: Basic Plumbing Materials and Methods.
 - 4. Section 22 1000: Plumbing.
 - 5. Section 22 2013: Plumbing Piping.

1.02 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 22 0500: Common Work Results for Plumbing.
- B. Submit product data and installation instructions for each item specified.
- C. Submit Samples of materials.

1.03 QUALITY ASSURANCE

- A. Comply with provisions of:
 - 1. Section 22 0500: Common Work Results for Plumbing.
 - 2. ANSI/ASME A13.1: Scheme for the Identification of Piping Systems.
 - 3. APWA: Uniform Color Code.
 - 4. IAPMO: Uniform Plumbing Code (UPC)

PART 2 – PRODUCTS

2.01 MATERIALS

- A. General: Piping systems, controls, valves, apparatus, etc., except those that are installed in inaccessible locations in partitions, walls, and floors, shall be permanently identified.

2.02 VALVES

- A. Furnish prepared chart or diagram for each piping system, indicating by identifying letter or model number of each valve in the system, its location, and function.
- B. Install charts in aluminum frame with clear glass front and secure on wall where designated by the Project Inspector.
- C. Bind copies of each chart in operating instructions manual.
- D. Provide each valve with a brass, aluminum, or plastic disc, not less than 1-1/4 inches diameter bearing engraved numbers corresponding to those indicated on chart. Fasten discs to valve with No. 14 brass wire.
- E. Provide an additional tag for safety valves and other valves that could be hazardous to safety and health of occupants. Distinguish these tags from regular valve tags by color (such as yellow with black letters, and marked "Danger"); submit Sample tag to the Architect for review.

2.03 INSTRUMENTS AND CONTROLS

- A. Identify panel-mounted instruments and controls with engraved bakelite nameplates permanently affixed to panel boards.
- B. Identify alarm indicating devices and alarm reset devices by nameplates.
- C. Identify automatic valves, flow switches, and pressure switches, with embossed aluminum or plastic tape affixed to controller, indicating service and setting.

2.04 EQUIPMENT

- A. Identify each major piece of equipment with engraved bakelite nameplates permanently affixed to the equipment, indicating the room numbers it services. Equipment identification designation shall be the same to its designation indicated on the "As-Built Drawings". Room numbers in the nameplates shall correspond to the final room numbers.

2.05 ABOVE GRADE PIPE IDENTIFICATION

- A. Identify pipes by means of colored labels with directional flow arrows and identification of the pipe content, in conformance to ANSI/ASME A13.1 or the UPC.
- B. Materials: Precoiled acrylic plastic with clear polyester coating, all-temperature, self-adhering, as manufactured by Brady, Brimar Industries, Seton, Stranco, Inc., or equal.
- C. Size:

Outside Diameter of Pipe or Insulation (in inches)	Length of Color Field (in inches)	Size of Letter (in inches)
3/4 to 1 1/4	8	1/2

1 ½ to 2	8	¾
2 ½ to 6	12	1 ¼
8 to 10	24	2 ½
over 10	32	3 ½

D. Locations:

1. On accessible piping, whether insulated or not (including mechanical rooms, attic and ceiling spaces); except that labels shall be omitted from piping where contained material is obvious due to its connection to fixtures (such as faucets, water closets, etcetera.).
2. Near each valve and branch connection in such accessible piping.
3. At each pipe passage through wall or floor.
4. At not more than 20 feet spacing on straight pipe run between bands required in 2 and 3 above.
5. At each change in direction.

E. Application: Install on clean surfaces free of dust, grease, oil, or any material that will prevent proper adhesion. Replace non-adhering or curling labels with new labels.

F. Color Schedule:

Content of Pipe	Legend	Background Color	Lettering Color
Domestic cold water	Domestic. C.W.	Green	White
Non-potable cold water	Caution: Non-potable Water Do Not Drink (1)(2)	Purple	Black
Domestic hot-water 140°F	Domestic H.W. 140°F	Blue	Black
Sanitary waste	San waste	Green	White
Sanitary vent	San vent	Green	White
Storm drain or downspout	Storm drain	Green	White
Indirect drain	Ind drain	Green	White
Sump pump discharge	Pump discharge	Green	White
Fire sprinkler supply	Fire Sprinkler supply	Red	White
Fire sprinkler drain	Sprinkler drain	Red	White
Fuel oil	Diesel oil	Yellow	Black
Gas	Gas	Yellow	White
Reclaimed Water	Caution: Reclaimed Water Do Not Drink	Purple	Black

	(1)(3)		

H. Notes on Schedule:

1. Note (1) indicates 2 ¼ inch by 1 inch yellow label with ½ inch letters reading UNSAFE WATER at one end of primary label.

Note (2) words should read "CAUTION: NONPOTABLE WATER DO NOT DRINK." with international *do not drink* symbol.

Note (3) words should read "CAUTION: RECLAIMED WATER DO NOT DRINK." with international *do not drink* symbol.

2.06 UNDERGROUND PIPE

A. Detectable Marking Tape:

1. Provide and install detectable marking tape along buried piping. Tape shall be specifically manufactured for marking and locating underground utilities with electronic equipment. Tape shall be acid and alkali resistant, and manufactured with integral wires or foil backing, encased with protective cladding. Tape shall be a minimum of two inches in width.
2. Manufacturer: Reef Industries, Inc., Advantage Brands, Inc., Northtown Company, Mutual Industries, Inc., or equal.
3. Detectable marking tape shall be color-coded per APWA Color Code:
 - a. Yellow: Oil and gas.
 - b. Blue: Water, irrigation and slurry lines.
 - c. Green: Sewer and drain lines.

B. Tracer Wire:

1. Solid copper wire type THWN, 12 AWG gauge, with heat and moisture resistant insulation.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Correct detrimental conditions prior to commencing the Work of this Section. Install markers and identification tags as specified with materials and installation procedures recommended by manufacturer.
- B. Place tracer wire on top of non-metal utility lines allowing some slack. Do not wrap tracer wire around pipe. Fasten tracer wire in place at approximately 10 feet on centers with non-metal ties.
- C. Install underground detectable pipe marking tape continuously buried 8 to 10 inches above the buried utility pipe. Wrap tape on pipe risers up to a height of 12 inches above grade.

3.02 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

**SECTION 22 0700
PLUMBING INSULATION**

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Insulation for plumbing piping.

B. Related Requirements:

1. Division 01: General Requirements.
2. Section 22 0500: Common Work Results for Plumbing.
3. Section 22 0513: Basic Plumbing Materials and Methods.
4. Section 22 0553: Plumbing Identification.
5. Section 22 1000: Plumbing.

1.02 REFERENCES

A. American Society for Testing and Materials International (ASTM):

1. ASTM C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation.
2. ASTM C411 - Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
3. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
4. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
5. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
6. ASTM C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
7. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
8. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

B. Underwriters Laboratories, Inc.

1. UL 723 - Test for Surface Burning Characteristics of Building Materials.
 - C. National Fire Protection Association:
 1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
 - D. California Code of Regulation Title 24.
 1. California Green Building Standards Code.
- 1.03 SUBMITTALS
- A. Submit in accordance with Division 01 and Section 22 0500: Common Work Results for Plumbing.
 1. Complete material list of items to be furnished and installed under this Section.
 2. Manufacturer's specifications and other data required demonstrating compliance with the specified requirements.
 3. Shop Drawings, catalog cuts and manufacturer's data indicating insulation, jacketing, adhesives, and coating. Insulating materials shall be certified by manufacturer to comply with the California quality standards for insulating materials.
 4. Display sample cutaway sections.
 5. Manufacturer's recommended method of installation procedures, which will become part of this Section.
- 1.04 QUALITY ASSURANCE
- A. Qualifications of Manufacturer and Installer, Materials, Fabrication, Execution, and Standard of Quality: Comply with provisions stated under Section 22 0500: Common Work Results for Plumbing and Section 22 0513: Basic Plumbing Materials and Methods.
 - B. Insulation Work shall be in accordance with the California Building Energy Efficiency Standards, CBC, and Uniform Mechanical Code and the California Green Building Standards Code.
 - C. Test Ratings:
 1. Comply with provisions stated under Section 22 0500 and 22 0513 with emphasis on ASTM E84, NFPA 255, or UL 723. ASTM C167, ASTM C302, UL label or listing of satisfactory test results from the National Institute of Standards and Technology, or a satisfactory certified test report from an acceptable testing laboratory. Approval by the State Fire Marshal is required.

2. Furnish labels, legibly printed with the name of the manufacturer or listings indicate that fire hazard ratings do not exceed those specified for materials proposed for installation. Flame spread index of not more than 25 and smoke developed rating not exceeding 50.
 3. Tests shall be performed on each item individually when insulation, vapor barrier covering, wrapping materials, or adhesives are installed separately at the Project site.
 4. Test insulation, vapor barrier covering, wrapping materials and adhesives as an assembly when they are factory composite systems.
- D. Regulatory Requirements: Insulation furnished and installed under this Section shall meet minimum legal requirements of the Building Energy Efficiency Standards adopted and incorporated in the California Energy Commission, Title 24, Part 2, Chapters 2 through 53 and the California Green Building Standards Code unless otherwise noted, for the piping,
- E. Chemically based products such as sealers, primers, fillers, adhesives, etcetera must meet the California air quality regulations.

1.05 PRODUCT HANDLING

- A. Protection, Replacement, Delivery and Storage: Comply with provisions stated under Sections 22 0500: Common Work Results for Plumbing and 22 0513: Basic Plumbing Materials and Methods.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. General:
1. Insulating material shall be fire resistant, non-corrosive, shall not break, settle, sag, pack or disintegrate under vibration, nor absorb more than 1 percent moisture by weight.
 2. Insulating material shall be furnished with thickness indicated in Table 1, and shall furnish thermal resistance in the range of R-4.0 to 4.6 in accordance with inch at 75 degrees F. For any other value of R, insulation thickness shall be calculated accordingly and submitted for review.
 3. Asbestos in any quantity in insulating material is not permitted.
 4. Provide insulation materials, adhesives, coatings, sealants, fitting covers, and other accessories with a fire hazard rating not to exceed 25 for flame

spread, 25 for fuel contributed and 50 for smoke developed, except for materials listed as follows:

a. Nylon anchors for installing insulation to equipment.

b. Treated wood blocks.

5. Flame-proofing treatments subject to moisture damage are not permitted.

TABLE 1 - MINIMUM PIPING INSULATION THICKNESS ⁽¹⁾

Insulation Thickness Required (in inches)

Piping System Type	Temp. Range (degrees F)	Runouts up to 2 (2)	1 and less	1.25 to 2	2.5 to 4	5 to 6	8 and larger
Service Water Heating Systems (recirculating, piping supply and return)							
Hot Water	Up to 180	0.5	1.0	1.0	1.5	1.5	1.5
Condensate Drain	½ inch minimum insulation thickness.	0.5	0.5	0.5	0.5	0.5	0.5
From A/C Equipment:	Insulate condensate drain lines within building, in room, inside walls and above ceilings.	0.5	0.5	0.5	0.5	0.5	0.5

NOTES: (1) For piping exposed to ambient temperatures, increase thickness by 0.5 inch.

(2) Runouts to individual terminal units, not exceeding 12 feet in length.

B. Lagging Adhesives: Shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Insulation finished with canvas shall be provided with laps adhered in accordance to manufacturer's recommendation. A finish coat of same material shall be applied to entire outer surface of lagging cloth at coverage specified by manufacturer.

C. Canvas Jackets: Provide 6 ounce, in accordance with square foot minimum, 48 by 48 thread count canvas jacketing.

D. Insulation Jackets:

1. Exterior insulation exposed to weather shall be weatherproofed with Childers aluminum jacketing as basis of design, or Pabco, RPR, or equal. Jacketing shall be manufactured from 1100, 3105 or 5010 aluminum alloy with 3/16 inch corrugations. Smooth or embossed jackets may be permitted in special situations to match an existing installation. Jacketing

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shall be furnished with an integrally bonded moisture barrier over entire surface in contact with insulation. A minimum thickness of 0.016 aluminum jacketing is to be provided on ducts and piping. A minimum thickness of 0.020 shall be provided on tanks, equipment, and heat exchangers.

2. Insulated elbows, of 90 degrees and 45 degrees, with a nominal iron pipe size of ½ inch to 8-inch shall be provided with Childers aluminum Ell-Jacs insulation covers as basis of design, or Pabco, RPR, or equal, manufactured from 1100 aluminum alloy of 0.024 inch thickness. Insulated elbows with a nominal pipe size of 10-inch to 18-inch shall be provided with Childers 4-piece aluminum Ell-Jacs as basis of design, or Pabco, RPR, or equal.
 3. Tees, Flanges, and Valve Insulation in Conjunction with Aluminum Jacketing: Furnish Childers Aluminum Special Fabrications Insulation Covers as manufactured by Childers Products Company, Pabco, RPR, or equal.
- E. Adhesives: Adhesives shall be water based, UL Classified, meet the requirements of NFPA 90A and NFPA 90B, have been tested according to relevant ASTM requirements, and be acceptable to the State Fire Marshal. Name, type and method of installation shall be submitted for review.
- F. Valve and Fitting Cover: When installed in conjunction with PVC jacketing, furnish Zeston 25/50 rated polyvinyl chloride fitting covers as manufactured by Johns Manville, Knauf Insulation, Speedline, or equal.

2.02 DOMESTIC HOT WATER PIPING SYSTEM INSULATION

- A. General: Insulate domestic hot water supply and return piping, including valves, strainers and fittings with insulation thickness as indicated on Table 1.
- B. Materials:
1. Classes of Insulation:
 - a. Class A: Glass fiber molded pipe insulation suitable for service temperatures up to 850 degrees F. Pipe insulation shall be one piece, preformed, and provide a minimum R factor of 4.0 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire retardant vapor barrier jacket. Pipe insulation shall be Johns Manville Micro-Lok, Knauf Redi-Klad 1000, Owens Corning FIBERGLAS Pipe Insulation SSL II-ASJ, or equal.
 - b. Class B: Flexible open-cell melamine (foam insulation) suitable for service temperature -150 degrees F to 400 degrees F. Thermal conductivity at 75 degrees F, K= 0.26. Pipe insulation, one-piece pre-formed, laminated to heavy non-reinforced PVC jacket, with

locking track, factory installed to jacket, to snap insulation and jacket onto pipe. Similar to TechLite 079 Series as manufactured by Accessible Products Co., or equal. Installation shall comply with manufacturers recommendations.

- c. Class C: Mineral fiber pipe insulation suitable for service temperatures up to 1200 degrees F. Pipe insulation shall be one-piece, preformed up to 3 inches thick, and provide a minimum R factor of 4.0 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire-retardant vapor barrier jacket. Pipe

insulation shall be 8 pounds in accordance with cubic foot density by Roxul Techton 1200, Fibrex COREPLUS 1200, Industrial Insulation Group, LLC (IIG) MinWool-1200, or equal.

2. Locations and Class of Insulation Required:

TABLE 2 – LOCATIONS AND CLASS OF INSULATION REQUIRED

<u>LOCATION</u>	<u>CLASS OF INSULATION</u>
Equipment Room	A, B or C
Other Locations	A, B or C

- 3. Fittings on indoor piping shall be covered with flush, hand-wrapped Class A, B, or C insulation, to match the adjoining pipe insulation and covered with polyvinyl chloride fitting covers: Zeston 2000 25/50 by Johns Manville, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal.
- 4. Adhesive: Fibrous Adhesive to bond calcium silicate to itself and non-porous surfaces.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Except as specified herein, install material in accordance with recommendations of manufacturer. Do not install insulation materials until tests specified in other sections are completed. Remove foreign material such as rust, scale, or dirt. Surfaces shall be clean and dry. Maintain insulation clean and dry at all times.
- B. On cold surfaces where a vapor barrier must be provided and maintained, insulation shall be installed with a continuous, unbroken moisture and vapor seal. Hangers, supports, anchors, or other projections that are fastened to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- C. Surface finishes shall be extended in such a manner as to protect raw edges, ends, and surfaces of insulation.

- D. Pipe or duct insulation shall be continuous through walls, ceiling or floor openings, or sleeves; except where firestop or firesafing materials are required.
- E. Metal shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Inserts shall be of equal thickness to adjacent insulation and shall be vapor sealed accordingly.
- F. Insulation shall not be installed in the following locations unless otherwise noted:
 - 1. On unions, flanged connections or valve handles.
 - 2. Over edges of any manhole, clean-out hole, clean-out plug, and to restrict opening or identification of access.
 - 3. Over any label or stamp indicating make, approval, rating, inspection, or similar data, unless provision is made for identification and access to label or stamp.

3.02 INSTALLATION OF DOMESTIC HOT WATER PIPING SYSTEM INSULATION

- A. General: Domestic hot water, tempered water supply and return piping and condensate return piping, after having been tested, shall be cleaned and insulated.
- B. Application: Insulate condensate return piping, domestic hot water supply and return, including tempered supply and return piping in accordance with manufacturer's instructions and as specified herein.
 - 1. Install insulation on valve bodies up to valve bonnet. Fill void in saddles, in accordance with Section 22 0513: Basic Plumbing Materials and Methods, with insulation and seal joints.
 - 2. Install insulating material to fittings, valves, and strainers and smooth to thickness of adjacent covering. Leave strainer clean-out plugs accessible. Covers fabricated from polyvinyl chloride shall be furnished.
- C. Insulation Jackets in Exposed Indoor Locations:
 - 1. Cover completed insulation with canvas jacket tightly pasted to covering with lagging adhesive. Lap jacket seams 1 1/2-inch minimum. Finish entire jacket with coating of undiluted adhesive.
 - 2. Equivalent factory applied pre-sized, glass fiber reinforced, or glass fiber jackets may be furnished. Seal jacket seams with adhesive in accordance with manufacturer's instructions.
 - 3. Johns Manville Zeston 2000, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal, fitting covers may be furnished, with molded or segmented insulation equal to specified insulation applied to fittings. Secure covers in accordance with manufacturer's instructions.

4. In addition to above requirements, cover exposed insulated piping within a distance of 8 feet above floors with 26 gage galvanized steel jacket. Omit jacket in areas accessible only to maintenance personnel, such as mechanical equipment rooms, utility corridors, accessible pipe tunnels and manholes.
- D. Concealed Indoor Locations: Cover insulation over fittings, valves, and strainers with canvas. Provide pipe insulation with factory or field applied standard jacket of 4 ounce minimum canvas, fiberglass cloth, or glass fiber reinforced jacket. Seal jacket laps with adhesive in accordance with manufacturer's instructions.
- E. Exposed Outdoors: In addition to canvas or fiberglass cloth cover, pipe insulation exposed to weather shall be provided with an additional 0.016 inches thick aluminum

jacket with 2-inch lap connected with one inch hem overlap joint located on side of pipe and turned down to shed water. Jacket shall be strapped 12 inches on center with ½-inch wide stainless steel strapping and wing seals. Aluminum jacket shall be mitered to fit fittings.

3.03 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.04 PROTECTION

- A. Protect the Work of this Section until Substantial Completion.

END OF SECTION

SECTION 22 1000
PLUMBING FIXTURES AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, tools, and equipment to install plumbing systems as indicated.
- B. Related Sections:
 - 1. Division 01 - General Requirements.
 - 2. Section 07 9200: Joint Sealants.
 - 3. Section 10 4413: Fire Extinguishers and Cabinets.
 - 4. Section 11 4013: Food Service Equipment.
 - 5. Section 12 3553: Laboratory Casework.
 - 6. Section 22 0500: Common Work Results for Plumbing.
 - 7. Section 22 0513: Basic Plumbing Materials and Methods.
 - 8. Section 22 0548: Vibration and Seismic Control for Plumbing Piping and Equipment.
 - 9. Section 22 0553: Identification for Plumbing piping and Equipment.
 - 10. Section 22 0700: Plumbing Insulation.
 - 11. Section 23 8000: Heating, Ventilating and Air Conditioning Equipment.
 - 12. Section 31 2323: Excavation, Backfill for Utilities.
 - 13. Section 33 3000: Site Sanitary Sewer Utilities.

1.02 SUBMITTALS

- A. Provide in accordance with Division 01 and Section 22 0500: Common Work Results for Plumbing.
- B. Provide necessary documentation to Owner for processing rebates for water efficient fixtures.

1.03 QUALITY ASSURANCE

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- A. Unless otherwise noted, the California Plumbing Code is hereby made part of this section.
- B. Conform to provisions of Section 22 0500: Common Work Results for Plumbing.
- C. Manufacturer of plumbing products must be third-party certified to ANSI/NSF Standard 61, Section 9 certification, and ANSI/NSF 372 to demonstrate compliance with the federal requirements for lead contribution to drinking water, the Safe Drinking Water Act SDWA, and the California Health and Safety Code Section 116875.

1.04 PRODUCT HANDLING

- A. Conform to provisions of Section 22 0513: Basic Plumbing Materials and Methods.

PART 2 - PRODUCTS

2.01 PIPING SYSTEMS

- A. Materials: Refer to Section 22 0513: Basic Plumbing Materials and Methods.
- B. Insulation for Piping: Refer to Section 23 0700: Plumbing Insulation.

2.02 FIXTURES AND DRAINS

- A. General: Fixtures specified shall be furnished complete with trim and fittings. Cast iron plumbing fixtures shall be acid resistant enamel, and identified by casting letters "AR" or words "acid-resistant" into metal. Fixtures shall be white unless otherwise specified. Cast iron fixtures shall be white enamel inside and on back, rim and apron, with exposed unfinished surfaces painted white. Fixtures of same general classifications shall be of same make.
- B. Finished Brass:
 - 1. Unless otherwise specified, finished brass of a similar type shall be of same manufacturer and model throughout buildings.
 - 2. Finished and exposed brass equipment, except floor, shower and urinal drains shall be chromium-plated and polished. Floor, shower and urinal drains, unless otherwise specified, shall be nickel-bronze metal.
- C. Traps, Trap Arms and Tailpieces:
 - 1. Fixture traps shall be all cast brass, chromium-plated and polished. (No tubular traps). Exceptions as follows:
 - a. Traps that are an integral part of a fixture.

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- b. Traps concealed in floors, walls and furring.
 - c. Traps standard for service sinks and Industrial Shop equipment.
 - d. Laboratory traps and tailpieces shall be as specified in section 22-0513 "Basic Plumbing Materials and Methods".
- 2. Concealed traps and 17 gage tailpieces may be rough brass finish, except as otherwise specified. Laboratory traps and tailpieces shall be as specified in Section 22-0513: Basic Plumbing Materials and Methods. Furnish chromium-plated and polished cast brass wall flanges with setscrews and chromium-plated and polished brass casing on discharge side of each trap.
- 3. Tailpieces shall be not lighter than 17 gage, brass, chromium-plated, and polished. Furnish and install chromium brass plated wall flanges with set screws and chromium-plated 20 gage brass casing on discharge side of each chrome-plated all cast trap.
- D. Faucet and Shower Valve Handles: Faucet and shower valve handles shall be solid brass, chromium-plated and polished, and fastened to their stems by Allen type hollow head stainless steel set screws through the side of the handle extending into the stem. Handles with sharp edges or projections shall not be furnished. At accessible fixtures: handles shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate handles shall be 5 pounds maximum.
- E. Fixture Supplies:
 - 1. Supplies for water heaters shall be unplated rigid copper water tube with threaded adaptors for connections to valves and other threaded connections. All other supplies shall be chromium-plated brass with hospital threads or shall be furnished with fittings and valves, which completely cover threads.
 - 2. Exposed supplies for showers shall be chromium-plated brass pipe up to header with hospital threads or shall be furnished with fittings and valves, which completely cover threads.
 - 3. Supplies to water closet tanks, lavatories, and drinking fountains shall be furnished with a NSF 372/61 threaded brass nipple. Exposed unfinished piping shall be sleeved with chrome plated brass or copper cover casing and have an appropriate escutcheon for a clean finished appearance. Angle/straight valve stops shall be female 1/2 IPS (inlet) by 3/8 compression (outlet). Fixture supplies shall be polished chrome-plated, solid supply bulbed end risers with size compatible supply nut connection to fixture and 3/8 O.D. compression nut and ferrule connection to angle stop outlet. Stainless steel flexible braided connectors with re-enforced PVC inner hose are not allowed.
 - 4. Hot and cold water fitting supply outlet piping serving water closets, urinals, lavatories, drinking fountains, sinks, faucets, hose bibs, and sillcocks shall be

iron pipe size (IPS) brass nipple, and piped in such a manner that through wall water supply outlet piping be removable, size appropriate, and lead free. The use of copper, copper MIP sweat adapters or similar fittings, in lieu of brass nipples is not allowed. The IPS brass nipple shall be directly connected to the fixture as follows:

- a. Control stops for water closet and urinal flush valves.
 - b. Angle stop for lavatories, sinks and drinking fountains.
 - c. Shank/arm adapters for wall mounted sink faucets.
 - d. Iron pipe size (IPS) brass nipple connection for hose bibs, sillcocks, and other plumbing related fixture and/or plumbing fitting water supply outlets.
5. Water supply pipe that penetrates a finished surface, wall, countertop or part of a cabinet shall be appropriately sized polished chromium-plated cover casing and wall flange/escutcheon fitting tight to the brass through wall nipple and securely affixed to the finished wall surface.
 6. Water supplies of plumbing fixtures shall be protected against back-siphonage in event of a vacuum in piping system. Toilet and urinal flush valves shall be furnished with recognized atmospheric vacuum breakers, installed a minimum of 6 inches above fixture.
 7. Discharge outlets of supply faucets for lavatories and sinks shall clear top of overflow rim by at least one inch.

2.03 ACCESS PLATES (To cleanouts, valves, water hammer arrestors and hose faucets)

A. Schedule Numbers:

AP-1: Square, unless otherwise noted, steel, prime coated; frame, 18 gage minimum. Door shall be 16 gage minimum with concealed hinge or be removable, with vandal-proof lock operated by Allen wrench. **(Specify for painted and stucco walls.)**

SMITH	ZURN	ELMDOR	MILKOR	WATTS	MIFAB	JOSAM
Fig 4760 AK	Z-1462- VP	DW-AKL	MOR DW AK1	CO-300- S-6	UA-A	58650-VP OR EQUAL

AP-2: Round type, stainless steel, vandal-proof, 5/16 inch No. 18 or 1/4 inch No. 20 flat-head machine screw into cleanout plug. Plate shall be prime coated minimum 18 gage steel or polished chrome-plated brass, 18-8 No. 302 stainless steel, or polished nickel bronze. **(To be specified for painted walls, screwed into cleanout plug.)**

SMITH	ZURN	JOSAM	WADE	WATTS	MIFAB	OR EQUAL
4710U	Z-1469-VP	58600	8480R	CO-480- RD-6	C1400-RD-6	

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- AP-3: Square, polished face chrome-plated bronze, aluminum alloy or brass chrome-plated brass frame with 14 gage polished 18-8 No. 302 stainless steel or brass chrome-plated secured cover with vandal-proof screws.
(To be specified for tile walls.)

SMITH	ZURN	WADE	WATTS	MIFAB	JOSAM	OR EQUAL
4735U	Z-1460-VP	58630	CO-300-S-6	C1400-S-3-6	58640-VP	

- AP-4: Square, floor type, cast nickel-bronze aluminum alloy or brass, with Carborundum or Scoriated, secured top.

(To be specified for floor access to solid interceptor in Science Room, Ceramic Room, and Agriculture Room.)

SMITH	ZURN	JOSAM	WATTS	MIFAB	OR EQUAL
4910U	Z-1461-VP	58630	CO-300-S-6	C1300-S-6	

2.04 BACKFLOW PREVENTION ASSEMBLIES

A. Schedule Numbers:

- BPV-1: Pressure vacuum breakers ½ inch to 2 inches, Los Angeles City approved.

(To be specified for irrigation lines to protect the potable water systems)

WILKINS	WATTS	FEBCO	OR EQUAL
720A	800M4QT	765	

- BPV-2: Non-pressure type, atmospheric vacuum breaker, Los Angeles City approved. **(To be specified for "Point-of-Use" conditions.)**

WATTS	WILKINS	OR EQUAL
LF288A	35XL	

- BPV-3: Reduced pressure or pressure differential type, Los Angeles City approved and in compliance with DWP Rule 16-D for meter protection. Sizes ½ inch to 6-inch.

(To be specified where potential health hazard exists and at main meter. Group component devices into a dual (parallel) configuration to avoid service interruptions during testing and servicing of devices. Devices shall be designed and installed in an above ground compact, low profile and serviceable valve station)

WILKINS	WATTS	FEBCO	OR EQUAL
375 and 975 XL (for uninterrupted service)	LF009-QT; LF909-NRS	LF860	

- BPV-4: Double check valve assembly for water protection. Sizes 2 ½-inch to 6-inch.

(Specify with non-toxic systems or where no potential health hazards exists. Devices shall be designed and installed in an above ground compact, low profile and serviceable valve station)

FEBCO	WILKINS	WATTS	OR EQUAL
LF870V	350	LF709	

BPV-5: Double check valve assembly. Sizes ¾ inch to 2-inch.

(To be specified with non-toxic systems or where no potential health hazard exists.)

WILKINS	WATTS	FEBCO	OR EQUAL
950XL	LF007	LF850	

BPV-6: Pressure vacuum breakers with 3/4 inch hose bib. Install 6 feet above finished floor.

WILKINS	WATTS	FEBCO	OR EQUAL
420XL	LF008PCQT	LF765	

2.05 BACKWATER SEWER VALVE ASSEMBLY

A. Schedule Numbers:

BSV-1: Cast iron with access cover, Los Angeles City approved type, with line size gate valve upstream and downstream.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
7022-S	Z-1090	BV-200	BV-1000	67500	

2.06 CLEANOUT ASSEMBLIES

A. Cleanout plug shall be line size.

B. Schedule Numbers:

CO-1: Iron body cleanout tee full line size up to 4 inches and round access plate, plugs shall be brass, countersunk with tapped boss for 5/16 inch No. 18 or ¼ inch No. 20 screws. **(Specify for finished walls at base of waste stack, above urinal and service sink.)** AB&I and TYLER may be used as iron body cleanouts. Trim and accessories shall be Smith or Zurn or equal.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
4532-U	Z-1446-BP	CO-460-RD-34B	C1460-RD-6	58600-CO	

CO-2: Iron body with approved UPC plug, top and adjustable sleeve, cut-off ferrule, polished scoriated brass nickel bronze secured cover. AB&I and TYLER may be used as iron body

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cleanouts. Trim and accessories shall be Smith or Zurn or equal **(To be specified for finished floors inside buildings, in covered areas, and in concrete paving.)**

Square:

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
4053L-U-NB	ZN-1400-T	CO-200-S	C1220-S-1-6	55000-1-SQ	

Round:

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
4033-L-U-NB	ZN-1400	CO-200-R	C1220-1-6	55000-1	

CO-3: Secured cover, extra heavy-duty, adjustable sleeve, cut-off ferule, UPC. Brass approved type plug, scoriated tractor type cover.

(To be specified for areas outside building on concrete paving.)

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
4233-U	ZN-1400-HD	CO-200-RX-4	C1220-4-6	55000-22	

CO-4: Tapped soil tee with brass plug, full line size.

(Specify for above grade, outside building at base of exposed downspout.)

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
4512	Z-1445-BP	CO-460-34A	C1460	58910	

CO-5: Raised threaded head brass plug.

(To be specified for yard box YB-3.)

ZURN	WATTS	SMITH	JOSAM	OR EQUAL
Z-1470-A	CO-590	4285	58540-20	

2.07 CIRCULATING PUMPS, HOT WATER HEATING SYSTEM

A. Schedule Numbers:

CPH-1: Centrifugal, single stage, close coupled with adjustable cast iron base, bronze enclosed impeller, lead-free mechanical shaft seal suitable for water temperature range from 20 degrees to 300 degrees F. Screwed or flanged connections. GPM and TDH capacities as indicated.

BELL & GOSSETT	WEIMAN	PACIFIC	TACO	OR EQUAL

CPH-2: In-line mounted. Close coupled, centrifugal type with an all bronze water chamber, bronze sleeve bearings, bronze impellers, water-tight shaft seal suitable for water

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temperature range from 20-300 degrees F. Forged steel shaft. It must be provided with bracket support to damper vibrations. GPM and TDH capacities as indicated.

BELL & GOSSETT All Bronze	GRUNDFOS	TACO	OR EQUAL

2.08 DRINKING FOUNTAINS

- A. Also see Electric Water Coolers, below.
- B. Drinking Fountains shall be provided with brass free waterways and lead mitigating water filtering systems (DFWF), ANSI-NSF 53 certified, to remove Lead and other contaminants having detrimental health effects.
- C. Schedule Numbers:

DFWF-1: In-line head and Cartridge assembly for drinking fountains, with ANSI/NSF 61, ANSI/NSF 372, CSA-B483.1-07, and ANSI/NSF 53 listed 1/4 Turn Cartridge with 0.5 Micron sediment/Carbon pre-filter.

FILTER	MODEL	
AQUA PURE	3MFF100	OR EQUAL

DFWF-2: In-line head and Cartridge assembly, for single bubbler drinking fountains components, with ANSI/NSF 61, ANSI/NSF 372, CSA-B483.1-07, and ANSI/NSF 53 listed 1/4 Turn Cartridge with 0.5 Micron sediment/Carbon pre-filter.

FILTER	MODEL	
CUNO	FM DWS 1500	OR EQUAL

- DF-1: Multiple bubblers, wall mounted cast iron with white porcelain enamel finish with two integral basin shank vandal resistant bubbler heads, with brass free waterways. Brass free flow/pressure regulating valves with flow-adjustable push buttons. Include chrome-plated cast brass grid waste strainer with integral keyed locking lugs for vandal resistance. A stainless steel screen water supply strainer, mounting brackets and vandal-resistant bottom plate shall be furnished. Complete drinking fountain with trim and brass free fittings must be certified to ANSI/NSF 61, and ANSI/NSF 372 lead free. **(For indoor or outdoor use. at Kindergarten, Middle School and High School, where access compliance is not required.)**

HAWS		OR EQUAL
1430		

- DF-2: Multiple bubbler, access compliant wall-mounted cast iron with white porcelain enamel finish, with two integral basin shank vandal-resistant bubbler heads, with brass free flow/pressure regulating valves and flow-adjustable push button activation. Chrome-plated cast brass grid waste strainer with integral keyed locking lugs for

vandal resistance. A stainless steel screen water supply strainer, mounting brackets, and vandal-resistant bottom plate shall be furnished. Install with 1/4 inch thick steel mounting plate inside the wall. Complete drinking fountain with trim and brass free fittings must be certified to ANSI/NSF 61, and ANSI/NSF 372 lead free. **(For indoor or outdoor use. at Kindergarten, Middle School and High School)**

HAWS		OR EQUAL
1431		

- DF-3: Multiple Bubblers, wall-mounted, white enameled cast iron drinking fountain, with three integral basin shank vandal-resistant bubbler heads, with brass free flow/pressure regulating valves, push button activation, chrome-plated cast brass grid waste strainer with integral keyed locking lugs for vandal resistance. A stainless steel screen water supply strainer, mounting brackets, and vandal-resistant bottom plate shall be furnished. Complete drinking fountain with trim and brass free fittings must be certified to ANSI/NSF 61, and ANSI/NSF 372 lead free. **(To be specified for outdoor use located on High School Sanitary unit at Athletic Field.) Where access compliance is not required.**

HAWS	OR EQUAL
1435	

- DF-4: Single Bubbler, access compliant wall-mounted, recessed, 18 gage Type 304 stainless steel drinking fountain with satin finish, furnished with a single integral basin shank vandal-resistant bubbler head, with brass free flow/pressure regulating valve, push button activation, vandal-resistant chrome-plated solid brass flat waste strainer, and a stainless steel screen water supply strainer at the inlet. Complete drinking fountain with trim and brass free fittings must be certified to ANSI/NSF 61, and ANSI/NSF 372 lead free. **(To be specified for indoor use, access compliant, requires frontal approach provision).**

OASIS	MURDOCK	HALSEY TAYLOR	OR EQUAL
F240PM	A181400S	BFM L/R	

- DF-5: Single bubbler, access compliant, recessed alcove wall-mounted drinking fountain with matching cuspidor combination, dual 18 gage Type 304 stainless steel receptors with satin finish, furnished with a single integral shank vandal-resistant bubbler head in the fountain, with brass free flow/pressure regulating valve, push button activation, a stainless screen water supply strainer at the inlet, a chrome-plated cast brass water spreader in the cuspidor, and chrome-plated solid brass flat waste strainers in both. Complete drinking fountain with trim and brass free fittings must be certified to ANSI/NSF 61, and ANSI/NSF 372 lead free. **(To be specified for indoor use in Physical Education and Gymnasium locations, access compliant use DF-4 in Exercise Gymnasium. For use in High School Gymnasium Building and Middle School Physical Education Building, delete use of cuspidor in Exercise Gym. Limit the installation of cuspidor to the replacement projects only. Requires frontal approach provision.)**

MURDOCK	HALSEY TAYLOR	OR EQUAL
A181400S-CUSP	8880 W/10245 CUSPIDOR	

DF-6: Single bubbler, recessed alcove wall-mounted drinking fountain furnished with matching cuspidor combination, dual 18 gage Type 304 stainless steel receptors with satin finish, furnished with a single integral shank vandal-resistant bubbler head in the fountain, with brass free flow/pressure regulating valve, push button activation, stainless steel screen water supply strainer at the inlet, a chrome-plated cast brass water spreader in the cuspidor, and chrome-plated solid brass flat waste strainers in both. Complete drinking fountain with trim and brass free fittings must be certified to ANSI/NSF 61, and ANSI/NSF 372 lead free. **(To be specified for indoor use in Physical Education and Gymnasium locations for Non-ADA installation. Limit the installation of cuspidor to the replacement projects only.)**

OASIS	MURDOCK	OR EQUAL
FLF231PM	A181400S	

DF-7: Dual Height - Two unit, access compliant, wall-mounted, 14 gage Type 304 stainless steel dual height (high, low) drinking fountains, each of one-piece construction, with 1/4 inch thick stainless steel backs, furnished with two (one each unit) integral basin shank, vandal-resistant bubbler heads, with brass free flow/pressure regulating valves with flow adjustable push button activation, chrome-plated cast brass waste strainers, and with bottom plates, and with stainless steel screen water supply strainers at inlet. Install with a 3/16 inch thick steel mounting plate inside the wall. Complete drinking fountain with trim and brass free fittings must be certified to ANSI/NSF 61, and ANSI/NSF 372 lead free. **(To be specified for indoor, fully access compliant, or shaded outdoor locations subject to severe vandalism.)**

HAWS	MURDOCK	HALSEY TAYLOR	OR EQUAL
1119.14 with mounting plate 6700.4; 1117LN with mounting plate 6700.4	A152400S-FG- W32	HDFF-EBP	

DF-7A: Dual height – Two unit access compliant wall-mounted barrier free polymarble drinking fountain. “Hi-Lo” white polymarble barrier free drinking fountain that includes polished chrome-plated bubbler heads, recessed push button valves, vandal resistant bottom plates, integral mounting brackets, special in-the-wall mounting plate, and 1-1/2” NPT traps. Complete drinking fountain with trim and brass free fittings must be certified to ANSI/NSF 61, and ANSI/NSF 372 lead free. **(This unit to be specified for outdoor use where heat resistance is necessary.)**

HAWS	MURDOCK	HALSEY TAYLOR	OR EQUAL
1501 with plate 6715	A152J00S	HRFG-SEBP-VR	

DF-7B: Single bubbler, wall mounted, 14 gage Type 304 stainless steel drinking fountain of one piece construction with 1/4 inch thick stainless steel back. Furnished with integral basin shank vandal resistant bubbler heads, with brass free flow/pressure regulating valve with flow-adjustable push button activation, chrome plated cast brass waste strainer, with bottom plate, and stainless screen water supply strainer. Complete drinking fountain with trim and brass free fittings must be certified to ANSI/NSF 61, and ANSI/NSF 372 lead free.

(To be specified for indoor, or shaded outdoor locations subject to severe vandalism.)

HAWS	MURDOCK	HALSEY TAYLOR	OR EQUAL
1109.14 Mounting Plate: 6700.4 1107L or 1107LBP	A151400S-FG	HDFE-EBP	

DF-8: Access compliant single bubbler white porcelain enamel cast iron wall-mounted drinking fountain. Furnish with brass free waterways, integral basin shank vandal-resistant bubbler head, cast brass waste strainers, with stream adjustable push button operation pressure regulating valves. Bottom cover plates, low profile 1-1/4 inch cast brass trap, stainless steel screen water supply strainer. Access compliant; and certified to ANSI/NSF 61 and ANSI/NSF 372 lead free. Furnish a 3/16 inch thick steel mounting plate No. 6700, which can also be installed with model No. 6800 concealed carrier steel struts for additional support where wall-mounted fountain may be subjected to excessive leverage **(To be specified for indoor or outdoor general use.)**

HAWS	MURDOCK	HALSEY TAYLOR	OR EQUAL
1311 Mounting Plate 6700	A151J00S	HRFG-E	

DF-8A: Access compliant dual height white porcelain enamel cast iron wall-mounted drinking fountains; furnish with brass free waterways, integral basin shank vandal-resistant bubbler heads, cast brass waste strainers, stream adjustable push button operation pressure regulating valves. Bottom cover plates, low profile 1-1/4 inch cast brass traps, and stainless steel screen water supply strainer. Access compliant and certified to ANSI/NSF 61 and ANSI/NSF 372 lead free. Furnish a 3/16 inch thick steel mounting plate number 6715, which can also be installed with model No. 6800 concealed carrier steel struts for additional support where wall-mounted fountain may be subjected to excessive leverage. **(To be specified for indoor or outdoor general use.)**

HAWS	MURDOCK	HALSEY TAYLOR	OR EQUAL
1501 Mounting Plate # 6715	A152J00S	HRFG-SEBP-VR	

DF-9: ADA Hi-Low pedestal drinking fountains, one wheelchair accessible and one standing person drinking fountain bowls, with an ADA accessible Bottle Filling station, free-standing 3/16" thick phosphated-steel pedestal with silver solar reflective powder-coated finish, chrome plated brass push-button operated stainless steel valves with front access to service the water control cartridge and integral water supply strainer, and front accessible flow adjustment, with polished chrome-plated solid brass drinking fountain bubbler heads with laminar .45 gpm flow to prevent splashing and integral 5/8" dia. basin shank for vandal resistance strength, 100% lead-free waterways, with polished chrome-plated vandal-resistant waste strainers, vandal-resistant access plates, with integral mounting base, and integral mounting bracket to accommodate the optional drinking water filter, 1-1/2" waste. ADA & CBC

accessible, CSA Certified NSF/ANSI 61 Section 9, and NSF/ANSI 372. Basis of Design: Haws model 3612-01-1200 **(To be specified for outdoor use in remote locations ONLY.)**

HAWS	OR EQUAL
3612-01-1200	

DF-10: Stand-alone bottle filler; shall be constructed of all 14 gauge type 304 stainless steel and no plastic shall be used in its construction allowing easy cleaning for maintenance. A laminar flow of water shall be activated with a front mounted and ADA accessible push button and be within ADA reach guidelines when properly installed. All waterways shall be brass free and unit shall be certified to ANSI/NSF 61 and ANSI/NSF 372 lead free. Fixture shall meet ADA, ADA Standing Person or ADA Child requirements when mounted appropriately. No electricity shall be needed to operate the unit. For bubbler stream activation, a non-proprietary, adjustable flow push button activated cartridge shall be used. **(To be specified for indoor, or shaded outdoor locations subject to severe vandalism.)**

Murdock	OR EQUAL
BF3 Semi-Recessed Installation	

DF-11: Single bubbler, wall mounted one piece stainless steel drinking fountain, with bottle filler constructed of all 14 gauge type 304 stainless steel and no plastic shall be used in its construction for vandal resistance. A laminar flow of water shall be activated with a front mounted and ADA accessible push button and be within ADA reach guidelines when properly installed. Any excess water draining into the fountain basin shall utilize a single common drain for both fountain and bottle filler. All waterways shall be brass free and unit shall be certified to ANSI/NSF 61 and ANSI/NSF 372 lead free. No electricity shall be needed to operate the unit. For bubbler stream activation, a non-proprietary, adjustable flow push button activated cartridge shall be used. **(To be specified for indoor, or shaded outdoor locations subject to severe vandalism.)**

HAWS	OR EQUAL
1920 bottle filler with BP15 back panel, 6700 mounting plate, with 1107L-BP7 drinking fountain.	

DF-11A: Dual Height - Two unit, access compliant, wall-mounted, one piece 14 gage Type 304 stainless steel dual height (high, low) drinking fountains, with bottle filler constructed of all 14 gauge type 304 stainless steel and no plastic shall be used in its construction for vandal resistance. A laminar flow of water shall be activated with a front mounted and ADA accessible push button and be within ADA reach guidelines when properly installed. Any excess water draining into the fountain basin shall utilize a single common drain for both fountain and bottle filler. All waterways shall be brass free and unit shall be certified to ANSI/NSF 61 and ANSI/NSF 372 lead free. No electricity shall be needed to operate the unit. For bubbler stream activation, a non-proprietary, adjustable flow push button activated cartridge shall be used. **(To be specified for indoor, or shaded outdoor locations subject to severe vandalism.)**

HAWS	OR EQUAL
1920 bottle filler with BP32 back panel, 6700.4L mounting plate, with 1117LN drinking fountain.	

DF-12: Single bubbler, wall mounted white porcelain enamel cast iron drinking fountain, with bottle filler constructed of all 14 gauge type 304 stainless steel powder-coated white and no plastic shall be used in its construction for vandal resistance. A laminar flow of water shall be activated with a front mounted and ADA accessible push button and be within ADA reach guidelines when properly installed. Any excess water draining into the fountain basin shall utilize a single common drain for both fountain and bottle filler. All waterways shall be brass free and unit shall be certified to ANSI/NSF 61 and ANSI/NSF 372 lead free. No electricity shall be needed to operate the unit. For bubbler stream activation, a non-proprietary, adjustable flow push button activated cartridge shall be used. **(To be specified for indoor or outdoor general use.)**

HAWS	OR EQUAL
1920W bottle filler with BP15W back panel, 6700 mounting plate, with 1311-BP-8W drinking fountain.	

DF-12A: Dual Height - Two unit, access compliant dual height (high low) white porcelain enamel cast iron drinking fountains, with bottle filler constructed of all 14 gauge type 304 stainless steel powder-coated white and no plastic shall be used in its construction for vandal resistance. A laminar flow of water shall be activated with a front mounted and ADA accessible push button and be within ADA reach guidelines when properly installed. Any excess water draining into the fountain basin shall utilize a single common drain for both fountain and bottle filler. All waterways shall be brass free and unit shall be certified to ANSI/NSF 61 and ANSI/NSF 372 lead free. No electricity shall be needed to operate the unit. For bubbler stream activation, a non-proprietary, adjustable flow push button activated cartridge shall be used. **(To be specified for indoor or outdoor general use.)**

HAWS	OR EQUAL
1920W bottle filler with BP32W back panel, 6700.4L mounting plate, and 1501 drinking fountain.	

2.09 DRUM TRAPS

A. Schedule Numbers:

DT-1: Extra heavy cast iron, bolted top.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
8714	ZA1180	SI-742-X	MI-SOLID-S	61030	

DT-2: Aluminum solid interceptor, furnish for on-floor installation.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
8710-AA	Z-1180	SI-742	MI-SOLID-S-AL	61030-26	

2.10 DIELECTRIC UNIONS

A. Schedule Numbers:

1. Dielectric style Unions using ferrous and no-ferrous metals are prohibited. Dielectric flanges are admitted for use – see DU-2.

DU-1: Lead Free Brass union with 6-inch Lead Free Brass nipple.

DU-2: Lead Free Brass union or Lead Free Brass flanged fittings are to be used in between pipes made of dissimilar metals to prevent accelerated corrosion and deterioration in the piping systems due to galvanic and stray current.

WATTS	WILKINS	ZURN	NIBCO	OR EQUAL
LF3100M3			733-LF	

2.11 EMERGENCY EYE WASH / EMERGENCY SHOWER

(Emergency eye wash/emergency shower equipment must meet OSHA safety order requirements)

A. Schedule Numbers:

EEW-1: Access compliant combination emergency shower and fold-away eyewash mounted in a flush mounted recessed stainless steel cabinet with concealed piping: Eyewash: eye/face wash in a stainless steel door/water tray assembly folds up flush into stainless cabinet. Shower: access compliant shower activation by pull lever handle mounted 42 to 45 inches above the finished floor, located inside of stainless steel cabinet, supplying an exposed 20 gpm flow regulated stainless steel shower head, mounted between 82 and 96 inches above finished floor. Unit is access compliant when eye/face wash spray outlet is mounted at a height of 36 inches above finished floor. Provide 30 inches wide by 48 inches deep clear floor space for access compliance. **(To be specified in Middle School and High School Science Lab Classrooms.)**

HAWS	GUARDIAN	ACORN SAFETY	BRADLEY	OR EQUAL
8356WCC	GBF2150-FC20	S2260-BF-PAN-RA	S19345JXB	

EEW-2: Access compliant combination emergency shower and fold-away eyewash mounted in a wall-surface mounted stainless steel cabinet. Eyewash: Eye/face wash in a stainless steel door/water tray assembly folds up flush into stainless steel cabinet. Shower: access compliant shower activation by pull lever handle mounted 42 to 45 inches above the finished floor, located inside of stainless steel cabinet, supplying an exposed 20 gpm flow regulated stainless steel shower head, mounted between 82 and 96 inches above finished floor. Unit is access compliant when eye/face wash spray outlet is mounted at a height of 36 inches above finished floor. Provide 30 inches wide by 48 inches deep clear floor space for access compliance.

(To be specified in Middle School and High School Lab Classrooms where recessed cabinet cannot be used.)

HAWS	GUARDIAN	ACORN SAFETY	OR EQUAL
8356WCSM	GBF2173	S2460-PAN-RA	

EEW-3: Access compliant deck mounted eye/face wash, chrome plated brass flow regulated fold-down Eye/face wash assembly mounted on the back-ledge of the sink, water is automatically activated when the assembly is pulled forward and down over the sink. The floor space for the approach, the sink size, the counter height, and under-counter knee clearance must be adjusted to meet accessibility requirements; the Eye/face wash spray heads should not exceed 36 inches above the finished floor.

(To be specified only at Science Prep Rooms immediately accessible to a lab that has a deluge shower. At Prep Rooms not immediately accessible to a lab with a deluge shower, specify an emergency shower/eyewash combination unit instead.)

HAWS	GUARDIAN	ACORN SAFETY	BRADLEY	OR EQUAL
7610	GBF1779	S0860-RH	S19274JDB	

EEW-4 Floor mounted combination emergency shower and eyewash shower: maximum output flow controlled to 20 gpm, chrome plated bronze stay-open shower control valve with stainless steel valve stem and stainless steel lever and pull rod. 1 ¼-inch galvanized pipe and fittings, with alternate 1 ¼-inch inlets and 9-inch diameter floor flange. Eye/Face Wash: Stainless steel eyewash bowl, pressure regulating flow controlled Eye/face wash with auto-open protective cover, chrome plated bronze stay-open eyewash valve with stainless steel ball and valve stem, protected by an easily serviceable in-line 50 by 50 mesh chrome plated brass strainer, large stainless steel push paddle for hand operation.

(To be specified in Pool Chlorination Rooms, Maintenance, Mechanical, or Janitorial spaces where chemicals and injurious irritants are stored or routinely used; access compliant.)

HAWS	GUARDIAN	ACORN SAFETY	BRADLEY	EQUAL
8309WC	GBF1909	S1340-BF	S19314AA2AEDA00	

2.12 ELECTRIC WATER COOLERS

A. Water Coolers shall be provided with brass free waterways and lead mitigating water filtering systems (DFWF).

B. Schedule Numbers:

DFWF-1: In-line head and Cartridge assembly, for single bubbler electric water coolers, with ANSI/NSF 61, ANSI/NSF 372, and CSA-B483.1-07 components, and with ANSI/NSF 53 listed 1/4 Turn Cartridge with 0.5 Micron sediment/Carbon pre-filter. **(REPLACEMENT CARTRIDGE ONLY) (To be specified for Single Bubbler applications).**

FILTER	MODEL	

CUNO	FM DWS 1500	OR EQUAL

DFWF-2: In-line head and Cartridge assembly, for multi-bubbler electric water coolers with ANSI/NSF 61, ANSI/NSF 372, and CSA-B483.1-07 components, and with ANSI/NSF 53 listed 1/4 Turn Cartridge with 0.5 Micron sediment/Carbon pre-filter. **(REPLACEMENT CARTRIDGE ONLY) (To be specified for Multi- Bubbler applications).**

FILTER	MODEL	OR EQUAL
AQUA PURE	3MFF100	

EWC-1: Wall-mounted electric chiller type UL listed for access compliant with minimum capacity of 8.0 GPH certified to comply with Air Conditioning and Refrigeration Institute (ARI) Standard 1010/73. Fountain with brass free waterways shall be furnished with stainless steel apron and cabinet push bar operated bubbler, automatic stream regulator, brass P-trap, and hermetically sealed, air-cooled condensing unit with 115 volt, single phase 1/5 HP motor with thermal overload protection (Hubbell No. 5264 or equal). Provide with approved 3-wire grounding cord and connector. Complete water cooler must have been tested and certified to ANSI/NSF 61 and NSI/NSF 372 lead free.

HALSEY TAYLOR	ELKAY	MURDOCK	OR EQUAL
HAC8SS-NF	EHFSA8	A171408F	

EWC-2: Dual-height electric water cooler, same mechanical specification as EWC-1 except fully access compliant, with dual height stainless steel drinking fountains sharing a common waste, water supply and refrigeration. Complete water cooler must have been tested and certified lead free to ANSI/NSF 61 and NSI/NSF 372 lead free.

(To be specified for Administration Area, Teachers' Lounge and Multi-Purpose Rooms)

MURDOCK	ELKAY	HALSEY TAYLOR	OR EQUAL
A172408F-UBL	VRCHDTL8SC	HAC8BLPV-NF	

2.13 FAUCETS

- A. Access compliant faucets: Force to activate controls shall be no greater than 5 pounds. Self-closing metering, where specified, to remain open 10 seconds minimum when activated. Handles shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist.
- B. Schedule Numbers:
- F-1: Wall mounted ¾ inch hose-thread spout faucet with vacuum breaker with integral service stops and top wall brace, adjustable eccentric union inlet connections, rough chrome.

(To be specified for service sink and can wash.)

CHICAGO	AMERICAN STANDARD	ZURN	OR EQUAL
897-RCF	8344.112-RC	Z843MI-RC	

- F-2: Wall mounted stainless steel 8 inch spread faucet with lever handles and 8 inch swing spout with brass free waterways. **(To be specified for Faculty Dining Room, Nurses Station, Culinary sinks and food preparation sinks.)**

FISHER	OR STAINLESS STEEL EQUAL
53112	

- F-3: NOT USED

- F-4: Wall mounted stainless steel single water inlet fitting with 8 inch swing spout with brass free waterways. Furnish with lever handles and water conservation type aerator.

(To be specified for use at pot sinks, over range tops and Photo Finishing Rooms.)

FISHER	OR STAINLESS STEEL EQUAL
67628	

- F-5: Wall mounted single water inlet with a double jointed swing spout, heat resistant handle control valve, stainless steel.

(To be specified for pot sinks and over range tops – Engineer / Designer to specify the type and length of spout.)

FISHER	OR STAINLESS STEEL EQUAL
54119 OR 54836	

- F-6: Deck mount, single hole, hot and cold faucet with copper water supply.

(To be specified for use in Multi-Purpose Rooms, Work Rooms, and in Photography Dark Rooms.)

CHICAGO	ZURN	OR EQUAL
50-E2805-5ABCP	Z826A1-XL-CST-MY	

- F-7: Wall mounted, hot and cold, faucet with serrated nozzle and vacuum breaker assembly. **(To be specified for use in Photography Negative Rooms).**

CHICAGO	ZURN	T&S BRAS.	
445-219948		BL-5775-08	

- F-8: Wall mounted, cast brass, hot and cold faucet with adjustable Centers and with 5 ½-inch gooseneck spout.

(To be specified for use in Graphic Arts Room.)

CHICAGO	ZURN	T&S BRASS	OR EQUAL
445-218173AB	Z841C1-5F	B-0290-LN WITH 059X 6 INCH SPOUT	

- F-9: Single handle wall mounted - cold water only - faucet with chrome finish.

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(To be specified for use in Shops or classrooms with a single wall mounted faucet.)

CHICAGO	ZURN	OR EQUAL
332-E35ABCP	Z875F1-15F	

- F-10: Single deck mounted hot and cold faucet, rough-plated brass with vacuum breaker top brace, with hose end. Provide with copper tubing connectors.

(To be specified for Science Room Demonstration Table and Science Prep Rooms in laboratory classrooms.)

T&S	CHICAGO	ZURN	OR EQUAL
BL-5700-09	930CR44720	Z826U1-6M-MY	

- F-11: Deck mount single handle with 5 ½-inch goose neck spout laboratory type faucet with serrated hose outlet and vacuum breaker.

(To be specified for Peninsula Units & Island Type Workstations in Modern Science, Chemistry and Biology Rooms.)

CHICAGO	T & S	ZURN	OR EQUAL
928-369CP	BL-5709-08	Z-825 – U16M	

- F-12: Deck mounted stainless steel 8 inches wide spread faucet, with 8-inch swing spout, aerator and lever handles. **(To be specified for food preparation sinks, Culinary Sink, Nurses Station and Faculty Dining Rooms.)**

FISHER	OR STAINLESS STEEL EQUAL
57649	

- F-13: Wall mounted laboratory faucet with vacuum breaker and lab nozzle outlet. Heavy chrome-plated, single turret assembly, nickel and copper composition, ½ inch iron pipe size concealed angle stop with extended stem and spoke handle with vandal-proof plastic index button.

(To be specified for use in High School Science Room fume hood.)

CHICAGO	T & S	WATER SAVER	OR EQUAL
980-GN2BVBE7CP Stop: 962V0ABCP	BL-5560-01 BL-4720-02 BL-4750-01	L171WSA with VB L-2885 N-7	

- F-14: 4-inch center set lavatory faucet self-closing metering, to remain open 10 seconds minimum when activated., Hot and cold water inlets, adjustable time cycle and

chrome plated finish. Provide with copper tubing connectors. To be used with 4-inch center set Lavatory Sink.

(To be specified for Faculty restrooms, Student store and Cafeteria hand wash sinks - Access compliant.)

CHICAGO	ZURN	OR EQUAL
3600CR44597AB	Z86500-XL	

- F-15: Single water inlet lavatory faucet self-closing metering, to remain open 10 seconds minimum when activated. Adjustable time cycle with vandal resistant base plate and chrome plated finish.

(To be specified for student restrooms).

CHICAGO	ZURN	OR EQUAL
3400-ABCP	Z86100-XL-CP4	

- F-16: Deck mounted, single lever handle, cold water inlet fitting, with rigid swinging goose neck spout and aerator.

(To be specified for Art Classrooms, Shop and Industrial Craft Rooms, Ceramic, Science Rooms-replacement only, Elementary Classrooms, Kindergarten Classrooms, and Special Education, Classrooms).

CHICAGO	ZURN	T&S	OR EQUAL
350-E35ABCP	Z825B1-XL-15F	B-0305	

- F-17: Vertical wall mounted fitting with lever handles, rigid gooseneck spout and spray outlet. **(To be specified for all 3-foot wash sinks with vertical outlets for Art classroom, Shop and Industrial Craft rooms and Ceramic classrooms.)**

CHICAGO		OR EQUAL
225-261ABCP		

- F-18: Flushing Rim Sink faucet with atmospheric Vacuum breaker, ¾-inch hose tread outlet and wrist blade handles.

(To be specified for all clinical sinks for special education.)

CHICAGO	ZURN	T&S BRASS	OR EQUAL
814-VBCP	Z842D6-LSI-5XT	B-0651-06 W/ 6" INCH WRIST HANDLES	

- F-19: Deck mounted, stainless steel, 4-inch center set lavatory faucet wrist blade handles, hot and cold water inlets and chrome plated finish.

(To be specified for Nurse's office Lavatory Sink)

FISHER	OR STAINLESS STEEL EQUAL
58750 or 58696 with 6-inch gooseneck	

- F-20: Wall mounted, hot and cold faucet, chrome plated, with lever handles and 9 or 9 ½-inches goose-neck spout.

(To be specified for use in Administration Offices, Conference Rooms, Teacher Workrooms, and Library.)

CHICAGO	ZURN		OR EQUAL
445-L9E35ABCP	Z842J1-XL-5F		

- F-21: Deck mounted, hot and cold faucet with lever handles, rigid swinging goose-neck spout and aerator.

(To be specified for use in Administration Offices, Conference Rooms, Teacher Workrooms, and Library.)

CHICAGO	ZURN	T&S BRASS	OR EQUAL
50-E35ABCP	Z826B1-XL	B-0300-VR	

- F-22: Stainless steel deck mounted, single lever handle, cold water inlet fitting, with swinging goose neck spout, brass free waterways and aerator.

(To be specified for use in Elementary and Kindergarten Classroom sinks.)

FISHER	JUST	OR STAINLESS STEEL EQUAL
58149, 58017	JSFVR-5	

2.14 FLOOR DRAINS

A. Schedule Numbers:

- FD-1: Cast iron body, no hub with seepage pan and flat, round nickel bronze strainers not less than 5-inch diameter for 2-inch outlet bodies, 7-inch for 3-inch outlet bodies and 8-inch for 4-inch outlet bodies, with maximum of ½ inch square holes or slots not larger than ¼ inch by 1 ¼-inch.

(To be specified for use in locations other than tile floors.)

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
2005Y-A	ZN-415-B	FD-100-A	F1100-C-1	30000-A	

- FD-2: Same as specified for FD-1, except with square tops.

(To be specified for use in tile floors.)

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
2005Y-B	ZN-415-S	FD-100-M	F1100-C-S-1	30000-S	

- FD-3: Area type, with 8-inch diameter minimum cast iron top grates (no hub). Drain shall be vandal-proofed by securing grate to body with stainless steel Allen flat-head screws.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
2110-Y-U	Z-550-VP	FD-320-Y-6	F1320-4-6	32100-VP-Z	

- FD-4: Pavilion type with cast iron hinged top, with removable sediment bucket. Drain shall be vandal-proofed by securing grate to body with stainless steel Allen flat head screws. No hub; 4-inch drain in lunch area in lieu of clarifier.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
2230-Y-H-U	Z-610-H-NH-UP Z-541-NH-VP-H	FD-340-Y-SET-9-6	F1340-TFB-4-6	37810-14-VP-Z	

- FD-5: Gang shower, cast iron body with 5-inch diameter nickel-bronze vandal-proof strainer. No hub.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
2005-Y-NB-U-(A)	ZN-415- B-VP	FD-100-A-6	F1100-C-1-6	30000-A-VP	

- FD-6: For indirect waste. Cast iron body, with vandal-proof nickel-bronze top and funnel. No hub.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
3510-F11-NB5	ZN-415-E	FD-100-EF-1	F1100-C-EF-1	30000-E2-VP	

- FD-7: Drain parking garage floor (emergency drain) with cast iron body, flashing collar and cast iron tractor grate NO hub, vandal-proof top.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
2120Y-U	ZN-508-9-INCH VP	FD-320-Y-6	F1320-4-6	32100-TG-VP	

- FD-8: Area drain, cast iron body, round pedestrian grate set in square frame.

SMITH	ZURN	WATTS	MIFAB	JOSAM	EQUAL
1470Y-U-NB	ZN-158-VP	RD-200-CP-L-1	F1100-C-S8-1-6	23730-VP	

- FD-9: Planter drain, cast iron body, secured bronze dome with stainless steel mesh screen.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
2646Y	ZRB-352 with Z-1040 adaptor	FD-860	F1810-6	39600	

FD-10: Trash Drain Wash down Area Drain: Waste water diversion valve drain acts as an area drain for sanitary and rain drainage. When the hose Bibb is activated, the drain automatically diverts run offs to sanitary drain. Unit shall be approved by Los Angeles Testing Laboratory.

FOX Waste Water Diversion Valve System:	OR EQUAL
DD 600	

2.15 FLEXIBLE HOSES

A. Schedule Numbers:

FLH-1: Braided stainless steel metal hose (for gas use). US Flex, Metraflex, Nelson Dunn or equal.

FLH-2: Braided bronze metal hose (for non-pressure condensate connection use). US Flex, Metraflex, Nelson Dunn or equal.

2.16 FLUSH VALVE ASSEMBLY

A. Valves shall be furnished so that flush remains constant and will not require any adjustment.

1. Each flush valve shall be provided with a loose key, square shank, lock shield angle service stop connected to flush valve with a union connection.
2. Provide 17 gage pressed brass escutcheons for wall and fixture. Escutcheons shall be fastened to not turn or rattle.
3. Each flush valve shall be furnished with a vacuum breaker providing one inch opening to atmosphere, which will not leak under any degree of back pressure and will not restrict rate of flow more than 10% at 10 PSI, and will operate noiselessly.
4. Tailpiece shall not be lighter than 17 gage and shall be part of flush valve assembly.
5. Exposed metal parts of flush valve assembly shall be nickel or chromium-plated on a brass or copper base.
6. Refer to 2.02.E for fixture supplies.
7. Controls for water closet flush valves shall be mounted on the wide side of toilet areas.

B. Schedule Numbers:

FLV-1: Automatic Flush Valve for Water Closets: Battery-powered, sensor-operated, 17 gage chrome-plated brass or heavier with cover and with metal cover manual override button. Shall deliver 1.28 gallon of water at each operation.

SLOAN	ZURN	OR EQUAL
Royal 111 SMO-1.28	ZER6000AV-HET-CPM	

FLV-1a: Manual Flush Valve for Water Closet: Shall deliver 1.28 gallon of water at each operation.

SLOAN	ZURN	OR EQUAL
Royal 111-1.28	Z6000AV-HET	

FLV-2: Automatic Flush Valve for Urinals: Battery-powered, sensor-operated, automatic flush valve. Flush valve at 1/8 gallons per flush with manual override feature.

SLOAN	ZURN	OR EQUAL
Royal 186 SMO-0.125-DBP-OR	ZER6003AV-ULF-CPM	

FLV-2a: Manual Flush Valve for Urinals: shall deliver 1/8 gallon of water per flush.

SLOAN	ZURN	OR EQUAL
Royal 186-0.125-DBP	Z6003AV-ULF	

2.17 FLOOR SINKS

A. Schedule Numbers:

FS-1: Round, cast iron, acid-resistant enamel body with bottom aluminum dome strainer, less grate.

(To be specified for use in Multi-Purpose Buildings and Cafeteria Buildings.)

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
3400Y-10	Z-1950-1	FS-760-22	FS1760-22	49580A	

FS-2: 6 inches to 8 inches deep, square cast iron acid-resistant enamel, bottom aluminum dome strainer with nickel bronze rim and grate top.

(To be specified for use in Multi-Purpose Buildings, High School Cafeteria and Mechanical Equipment Rooms.)

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
3140Y 3150Y	Z-1901 ZN-1900	FS-740-1 or FS-730-1	FS1720-1, FS1730-1	49320A-NB, 49340A-NB	

FS-3: Round, cast iron body with dome bottom strainer, under deck clamp and 2-inch high water dam; no hub type.

(To be specified for outdoor use near cooling tower, near rooftop HVAC unit, chillers, Mechanical Equipment Rooms.)

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
3980Y-C	Z-108-NH	RD-400-F	R1200-RS-U	25500-1	

2.18 GREASE TRAPS (INTERCEPTORS)

A. Schedule Numbers:

GT-1: Cast iron, basket baffle assembly, Los Angeles City approved type.

BIG DIPPER	JR SMITH	JOSAM	ZURN	WATTS	MIFAB	OR EQUAL
	8000	60100H	1170	WD SERIES	MI-G	

GT-2: Pre-fabricated reinforced concrete with cast iron fittings, with manholes brought to grade. Size and capacity as indicated on Drawings. Los Angeles City approved.

BROOKS	JENSEN	PROCAST	OR EQUAL

2.19 HOSE BIBBS

A. Schedule Numbers:

HB-1: For plaster or stucco wall, furnished with box and stop, exposed trim chrome-plated, with or without door and with vacuum breaker.

(To be specified for use in swimming pool area, outside eating area and at 75 feet spacing around exterior building walls.)

ACORN	WOODFORD	PRIER	OR EQUAL
8141, 8151	B75	C-633NFC	

HB-2: For brick, CMU and poured in place concrete walls, furnished with box and stop, exposed trim chrome-plated, with or without door and with vacuum breaker.

(To be specified for use in swimming pool area, outside eating and 75 feet spacing around exterior building wall.)

ACORN	WOODFORD	PRIER	OR EQUAL
8141, 8104, 8151	B75	C-633NFC	

HB-3: ASTM B 62 bronze body, rubber composition disc or renewable seat, straight nose with brass die cast or enamel iron hand wheel and with vacuum breaker.

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(To be specified for use for Lath House.)

ACORN	ZURN	WOODFORD	PRIER	OR EQUAL
8131-RBVB	Z-1343-VB	Y24	C-155	

HB-4: Same as HB-3 except furnish loose key stop and lockshield.

(To be specified for use at animal wash-down areas.)

ACORN	ZURN	WOODFORD	PRIER	OR EQUAL
8131-LK-RBVB	Z-1343-VB-LK	Y24 WITH LOOSE TEE KEY	C-155	

HB-5: Same as HB-3 except furnish with bent nose.
(To be specified for use at roof top AC Unit. Mechanical Equipment Room, Boiler Rooms, etc.)

ACORN	ZURN	CHAMPION	PRIER	OR EQUAL
8126-LK-RBVB	Z-1343-VB-LK	B-401 LK	C-255NP	

HB-6: Same as HB-4 except furnish with bent nose and loose key handle.

(To be specified for use in exterior Agricultural Plot.)

ACORN	ZURN	CHAMPION	PRIER	OR EQUAL
8126-LK-RBVB	Z-1343-VB-LK	B-401LK	C-255NP	

HB-7: Renewable seat, rough chrome finish, bronze body, flanged 3/4 inch I.P.S. with Female thread inlet, loose key, and vacuum breaker.

ACORN	CHICAGO	WOODFORD	PRIER	OR EQUAL
8121-CR	No. 387-E-27	No. 24P-CH-TK	C-255CP	

HB-8: Recessed hose box furnished with wall flange and built-in drip lip. Box shall be one piece construction; door shall have a recessed cam lock. Door shall remain up and out of the way when in fully opened position. Valve shall be replaceable loose key wheel handle and screwdriver stop. Install within 2 feet above finished floor. Provide vacuum breaker.

(To be specified for use in Toilet Rooms.)

ACORN	WOODFORD	PRIER	OR EQUAL
Hose box 8104 or 8151	B75	C-634BX1	

2.20 LAVATORIES

- A. Access compliant faucets for Lavatories: Force to activate controls shall be no greater than 5 pounds. Self-closing metering, when specified, to remain open 10 seconds minimum when activated.
- B. Cast Iron Lavatories shall be acid resistant enamel and shall conform to Commercial Standards CS 77.63. Unites furnished in conjunction with strainer installation or faucet installation shall be brass. Exposed brass nuts shall be chrome plated.
- C. Exposed trim shall be free from sharp edges or points. Fixture shall be furnished with other listed manufacturer specified trim. Instead of solid supply pipe, polished chrome-plated risers, 3/8 inch outside diameter with ferrule stop end and metal nosepiece may be furnished.
- D. Insulate cold water, hot water and drain lines under all access compliant lavatories with approved type insulation.

PLUMBEREX	LAV-GUARD	OR EQUAL

Schedule Numbers:

- L-1: 20-inch by 18-inch cast iron, acid-resistant enamel punched with three holes, 4-inch on center and supplied with tempered or cold water only. Unit shall be furnished with cast iron hangers. Stops shall be loose key, square shank, lock shield type.

(To be specified for use in Student Toilet Rooms, Typing, Math, and Industrial Art Rooms.)

	COMMERCIAL ENAMEL	KOHLER	BRASS CRAFT	CHICAGO	ZURN OR EQUAL
Bowl	551 (3 holes)	K-2867			Z5844-CB
Faucet (See Section 2.13)	F-15	F-15	F-15	F-15	F-15
Drain				327 XCP	Z8743
Supply			HSTR 1720 A-CB-C	1017	ZH-8822-CE-LK

Note: Provide cast iron hangers for sinks.

- L-2: Same as L-1, 20-inch by 18-inch cast iron, acid resistant enamel punched with three holes, 4 inches on center and supplied with tempered cold water only. Unit shall be furnished with cast iron hangers. Stops shall be loose key, square shank and lock shield type. **(To be specified for access compliant, student restrooms).**

L-3: 20-inch by 18-inch cast iron, acid-resistant enamel lavatory, with 4-inch center set

	COMMERCIAL ENAMEL	ZURN	KOHLER	OR EQUAL
Bowl	553 (3 holes)	Z5844	K-2867	
Faucet (See Section 2.13)	F-15	F-15	F-15	
Drain	Chicago 1-1/4-inch grid drain 327- XCP	Chicago 1-1/4 inch grid drain 327- XCP	Chicago 1-1/4-inch grid drain 327- XCP	OR EQUAL

combination push button metered faucet, supplied with hot and cold water, complete with cast iron hangers. **(To be specified for non-accessible installation at nurse's office and faculty restrooms).**

	CECO	KOHLER	BRASS CRAFT	CHICAGO	ZURN	OR EQUAL
Bowl	551(3 hole)	K-2867			Z-5844	
Faucet (See Article 2.13)	F-14	F-14	F-14	F-14	F-14	
Drain		K-7715		327A	Z-8743	
Supply			HSTR 1720-A-CB-C	1017	ZH822-CE- LK	

L-4: 20-inch by 18-inch cast iron, acid resistant enamel lavatory with 4-inch center set combination push button metered faucet, supplied with hot and cold water complete with cast iron hangers. **(To be specified for access compliant installations at faculty restrooms).**

	COMMERCIAL ENAMEL	ZURN	KOHLER	OR EQUAL
Bowl	553 (3 holes)	Z5844	K-2867	
Faucet (See Article 2.13)	F-14	F-14	F-14	
Drain	Chicago 1 ¼-inch grid drain 327-XCP	Chicago 1 ¼-inch grid drain 327- XCP	Chicago 1-1/4- inch grid drain 327- XCP	OR EQUAL

L-5: 20-inches by 18-inches cast iron, acid-resistant enamel, with 4-inches on center set combination faucets with lever handles supplied with hot and cold water complete with hanger.

(To be specified for access compliant installations at Nurses' office and Health Units).

	AMERICAN STANDARD	CECO	KOHLER	BRASS CRAFT	CHICAGO	ZURN OR EQUAL
Bowl		553(3 hole)				
Faucet (See Article 2.13)	F-19	F-19	F-19	F-19	F-19	F-19
Drain	2411.015	K7715	K-7715		327A	Z8743
Supply				HSTR-1720- A-CB-C	1017	ZH-822- CE-LK

L-6: 16-inch by 14-inch (or size indicated on Drawings), enamel cast iron, complete with combination push button metered faucet, supply and drain fitting.

(To be specified for use in Student Store.)

	KOHLER	CHICAGO	BRASS CRAFT	ZURN	OR EQUAL
Bowl					
Faucet (See Article 2.13)	F-14	F-14	F-14	F-14	
Drain	K-7715	327A			
Supply		1017	HSTR 1720A-CB- C	ZH822-CE-LK	

2.21 LABORATORY GAS VALVES

- A. Gas valves shall be protected by access-compliant and serviceable electronically-operated gas solenoid valve. This valve shall be remotely operated by a recess-mounted controller with an emergency push button. Controller shall be located as close as possible to the teacher's work station with a 48" maximum mounting height for access compliance.
- B. Laboratory countertop and tabletop gas valves shall have integral check valves.
- C. Schedule Numbers:

LGV-1: Controller with an emergency push button, LED, and key switch in conjunction with a 24-volt, normally-closed solenoid valve.

MANUFACTURER	American Gas Safety, AGS	ISIMET	OR EQUAL
CONTROLLER	Merlin 1000Si, 24 VAC, Recessed Mount	LA SERIES, Model: LA1211-R	
SOLENOID	Normally Closed, Merlin Valve, 24VAC, 1/2" through 2"	Normally Closed, S-300 Series, 1/2" through 1-1/4"	

LGV-2: Ground key stop, heavy chrome-plated, nickel and copper composition, double turret at 90 degree angle 3/8 inch international pipe size deck type, with lever handle and vandal-proof plastic index button.

(To be specified for use in Middle School Science Room countertop tables.)

CHICAGO	T & S	WATER SAVER	ZURN	OR EQUAL
982-909CAGCP E7TC	BL-4200-02	YR2900-132AWSA	Z88200-Z-8001B-CS	

LGV-3: Laboratory gas valve, same as LGV-2, except single turret.

(To be specified for use in Middle School Science Room demonstration table.)

CHICAGO	T & S	WATER SAVER	ZURN	OR EQUAL
980-909CAGCP E7TC	BL-4200-1	YR2900-131- WSA	Z88200-Z-8001B-CS	

LGV-4: Same as LGV-2, except double turret at 180 degree angle.

(To be specified for use in High School Chemistry, Physiology, Biology, Physics, Modern Science and Science Room peninsula table.)

CHICAGO	T & S	WATER SAVER	ZURN OR EQUAL
981-909CAGCP E7TC	BL-4200-2	VR2900-132SWSA	Z-88200-Z-8001B-CS

LGV-5: Ground key stop, heavy chrome-plated, nickel and copper composition, single turret, wall-mounted, 3/8 inch international pipe size with lever handle and vandal-proof plastic index button.

(To be specified for use in Middle School Science Work Rooms.)

CHICAGO	T & S	WATER SAVER	ZURN	OR EQUAL
986-909AGVCP E7T	BL-4250-01	L2900-158	Z-88600-Z8001B	

2.22 LAUNDRY TRAYS AND TRIM

- A. Sinks specification herein shall be furnished with strainer and tailpieces unless otherwise noted. Supplies shall be 3/8-inches outside diameter.
- B. Schedule Numbers:
- LT-1: Cast iron, acid-resistant enamel, with strainer and 1 ½-inches tubing tailpiece, 24-inch by 21-inch by 13 ½-inch in cabinet top, with faucet, strainer and tray.

(To be specified for use in High School and Elementary Special Education, Storage/Laundry Room; access compliant.)

	AMERICAN STANDARD	CHICAGO	KOHLER	ZURN	CECO OR EQUAL
Tray sink					
Faucet	F-6 (Article 2.13, Faucets)	F-6	F-6	F-6	F-6
Strainer	4320.024		K-8807		OR EQUAL

- LT-2: Cast iron, acid-resistant enamel, 24-inch by 20-inch by 13-inch, black angle frame, with wall mounted faucet strainer and tray.

	AMERICAN STANDARD	KOHLER	CHICAGO	ZURN	CECO OR EQUAL

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22 1000-30

Tray sink					804
Faucet	F-3B (See Article 2.13, Faucets)	F-3B	F-3B	F-3B	F-3B
Strainer	4362.026	K-8820		Z8736	OR EQUAL

2.23 PIPE HANGERS

A. Refer to Section 22 0513: Basic Plumbing Materials and Methods.

B. Schedule Numbers:

1. PH-1: Complete with clamps, inserts, etc.

SUPERSTRUT	UNISTRUT	TOLCO	B-LINE	OR EQUAL

2.24 P-TRAPS

A. Schedule Numbers:

PT-1: Cast brass complete, chrome-plated.

	AB&A		OR EQUAL
	107		

2.25 PRESSURE REGULATING VALVE ASSEMBLIES

A. Schedule Numbers:

PRV-1: Furnish for sizes ½-inch to 2-inch water service, all bronze body, stainless steel seat, bronze strainer, calibrated springs, and corrosion resistant, adjustable control.

WILKINS	WATTS	OR EQUAL
500XL- YSBR-HLR	LF223S-B-HP	

PRV-2: Furnish for sizes 2 ½-inch and larger: Automatic (pressure) control valve-pilot controlled and diaphragm actuated pressure control valve, straight or angle pattern, flanged inlet and outlet connection, fusion bonded epoxy coated inside and out with stainless steel cover, stainless steel pilot, stainless steel bolts and nuts, and stainless steel flexible tubing in a compact configuration, vandal resistant bolt-on pilot controller, ¼ ball valve on all pilot control lines, and stainless steel internal parts.

WATTS	CLA-VAL	OR EQUAL
LFM115	90-01	

PRV-3: Furnish for sizes 1 ½-inch and larger; air service, Japanned steel, spring loaded, brass forging body, nylon reinforced neoprene diaphragm, inlet pressure up to 250 pounds, reduced pressure 5 pounds to 60 pounds.

MASON-NEILAN		MASTER PNEUMATIC	OR EQUAL
71 ½-inch	3464, ½ inch 3466, 3/4-inch	VANGUARD R200	

PRV-4: Furnish for gas service, spring-loaded model, Buna N rubber composition or leather valve seat disc and diaphragm, inlet pressure 125 pound maximum.

REPLANCE	FISHER	SENSUS	OR EQUAL
1813C	S-100. 166-1, S- 201, 166-2	121	

PRV-5: Furnish for gas service for (unit heaters, boilers, and similar installations). Spring-loaded model, Buna N rubber composition, or leather valve seat and diaphragm suitable for temperatures to 150 degrees F.; maximum inlet pressure one pound. Outlet pressure 4 inches to 10 inches adjustable; orifice to suit. For pilot lines and main burners.

REPLANCE	MAXITROL	HONEYWELL	OR EQUAL
A3000 Series	RV	V5172 Series	

2.26 ROOF DRAINS

A. Schedule Numbers:

RD-1: Low profile dura-coat cast iron body dome strainer type.

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
1010Y- ERC-CID	Z-100-ERC-M	RD-300-F- D-K40	R1200-EU-M	21500-22	

RD-1A:

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
1010Y- R-C-CID	Z100-89-RC- M	RD-300-D- K40	R1200-M-B- U	21500-17-22	

RD-2: Cast iron body with standpipe. (Specify for use as overflow.)

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
1080Y- ERC- CID	Z-100-89-ERC- M	RD-300-R- F-B-D-M	R1200-R-EU- M	21500-3-16- 22	

RD-2A:

SMITH	ZURN	WATTS	MIFAB	JOSAM	OR EQUAL
1080Y- R-C-CID	Z100-89-RC-M	RD-300-R- B-D-M	R1200-R-M- B-U	21500-3-17- 22	

2.27

SHOWER ASSEMBLIES

A. General: Shower assemblies shall be installed concealed in wall. Escutcheons are to be polished chrome plated fastened to walls with vandal proof screws. Heads shall be recessed type to cover male pipe threads or male threads shall be hospital type plated after threading and installed with not more than one thread showing. Nozzles shall be chrome-plated.

B. Schedule Numbers:

SA-1: Polished push button automatic shower limiter metering valve installed concealed in wall; polish chrome plated vandal proof screws to be used for escutcheon mounting. Shower shall be factory prepared and hydrostatically tested to 150 psi at the factory. Internal piping shall be Type L copper tubing. Fittings shall be cast bronze or copper, valves shall be tempered water and not to exceed 2.0 GPM. Flange showerhead shall be lockable universal ball joint. Exposed fasteners shall be tamper resistant. Shower station shall be 18 inches from each end and 36 inches on center and 74 inches vertical height, shower assembly shall be complete with mounting brackets and stanchions.

(To be specified for use in Secondary Schools for Boys' and Girls' group shower; P.E. Buildings)

Shower Valve	ZURN Z7530	CHICAGO 770-665 PSH	SYMMONS 4-420	OR EQUAL
Shower Head	ZURN 12	621	4-295 B	OR EQUAL

SA-2: Polished Mixing Handel automatic shower limiter metering hot and cold mixing valve installed with fixed spray / institutional showerhead concealed inside wall; Polished chrome plated with vandal proof screws for escutcheon mounting.

(To be specified for use in Secondary Schools for Male and Female Instructors – Private Showers in P.E. Buildings)

Shower Valve	ZURN Z7533	CHICAGO 1762 - VOCCP	SYMMONS S-96-2	OR EQUAL
Shower Head	ZURN 12	621 CP	4-141	OR EQUAL

SA-3: Polished pressure balancing mixing valve with single blade level handle, integral volume control and chrome plated brass escutcheon with hose and spray on sliding bar.

Plumbing Fixtures and Equipment
22 1000-33

(To be specified for access compliant use –Special education schools, Secondary Schools, Nurse’s work station, school Therapy Unit, Elementary Schools – access compliant toilet rooms, Occupational access compliant toilet room. Also see SA-4 below for hose and spray and other requirements.)

Shower Valve, Hose and Spray	ZURN Z7100 Valve Z7000 Hand-Shower	POWERS 450- 7054 E700	SYMMONS S- 96-500-4-141- H321	OR EQUAL

SA-4: Shower control valve requirements for Hose and Spray:

a. Vacuum breaker: Exposed or concealed piping.

Exposed piping	Concealed Piping	T&S BRASS	OR EQUAL
CHICAGO 892-GABCP	ZURN Z-80000-EVB	B-0929-A	

b. Wall spout: Wall spout with ½ inch female i.p.s. flange inlet and ½ inch male i.p.s. Outlet, chrome-plated.

CHICAGO	ZURN	T&S BRASS	OR EQUAL
892-ABCP	80000-SE	B-0968	

c. Hose and Bar: 5-foot long reinforced white vinyl hose with 24-inch adjustable bar with hand shower slide bracket, chrome plated.

d. Hand shower: Insulated handle with central lever stop valve, bent nozzle tube; rubber bound hose spray adapted for ½-inches hose connection.

SYMMONS	BRADLEY	ZURN	OR EQUAL
H 321	B 24	Z 7000-HW	

e. Diverter Valve: Transfer flow between showerhead and hand held shower.

ACRON	BRADLEY	SYMMONS	OR EQUAL
DV	DV	4-458	

f. Tempering Valve: The temperature range between 100 and 150 degrees Fahrenheit shall be background in red or red line enclosed. Valve shall be complete with fail safe feature, square shank loose key stops, checks and strainers on both hot and cold water inlets and shut-off valve on outlet to protect from scalding.

POWERS	LEONARD	LAWLER	OR EQUAL
Single Valve Hi-Lo			

2.28 SERVICE SINKS and TRIM

A. Schedule Numbers:

- SS-1: Cast iron, conforming to Commercial Standard CS 77.63 for acid-resistant enamel, 22-inch by 18-inch, with blank back, 2-inch outlet trap standard and rough-plated double faucet with top brace mounted above sink's back, furnished with vacuum breaker and hose end.

(To be specified for custodial use at receiving storage rooms.)

	AMERICAN STANDARD	CECO	KOHLER	ZURN OR EQUAL
Sink		867	K-6714-18	Z5880
Faucet	F-1 (See Article 2.13 – Faucets)	F-1	F-1	F-1
Trap Standard		870-2	K-6672	OR EQUAL

- SS-2: Cast Iron corner service sink, conforming to Commercial Standard CS 77.63 for acid-resistant enamel, 28-inch by 28-inch, coated wire rim guard, 2-inch flat strainer and rough-plated double faucet with top brace mounted above sink back, furnished with vacuum breaker and hose end.

(To be specified for use in Custodial Rooms.)

	CECO	American Standard	KOHLER	CHICAGO	ZURN OR EQUAL
Sink	871		K-6710		Z5850
Faucet	F-1 (See Article 2.13 – Faucets)	F-1	F-1	F-1	F-1
Rim Guard	B-872		K-8940		RC
Strainer	B-71-2		K-9142		D-2

2.29 SINKS and TRIM

- A. For classrooms, offices and dining room sinks.
- B. Access compliant faucets for sinks: Force to activate controls shall be no greater than 5 pounds. where specified self closing metering to remain open 10 seconds minimum when activated.
- C. Cast iron sinks shall be acid resistant enamel, and shall conform to Commercial Standards CS 77.63. Units furnished in conjunction with strainer installation or faucet installation shall be brass. Exposed brass nuts shall be chrome-plated. Refer to the Fixture Supplies paragraph of this section.

D. Exposed trim shall be free from sharp edges or points. Fixture shall be furnished with other listed manufacturer specified trim. Instead of solid supply pipe, polished chrome-plated risers, 3/8-inches outside diameter with ferrule stop end and metal nosepiece may be furnished.

E. For access compliant sinks: Insulate cold water, hot water and drain pipes under sinks with district approved type insulation.

PLUMEREX	LAV GUARD	OR EQUAL

F. Schedule Numbers:

ST-1: Cast Iron, 24-inch by 16-inch by 5-inch, flat rim, with 3 ½-inch flat strainer, and deck mounted stainless steel pantry faucet, mounted on left side center line, with stainless steel drinking bubbler mounted on right side near front.

(To be specified for use in Elementary and kindergarten classrooms.)

	AMERICAN STANDARD	HAWS	KOHLER	JUST
Sink		4110 ADA	K-5990	
Faucet		F-16 (see 2.13)	F-16 (see 2.13)	
Strainer	4311.023	6455	K-8807	
Bubbler				JSB-10-VR

ST-2: Same as ST-1, except stainless steel faucet on the right side and stainless steel bubbler on the left side.

(To be specified for use in Elementary and Kindergarten classrooms.)

ST-3: Cast Iron, 18-inch by 12-inch – 24-inch by 18-inch or 30-inch by 18-inch **(Designer to select and specify the size)** or as indicated on drawings, with basket strainer, hot and cold deck mounted faucet.

(To be specified for use in Administration Offices, Conference Rooms, Teacher Workrooms, Faculty Lounge, Library and Kiln Room.)

	KOHLER	AMERICAN STANDARD	CECO	HAWS	OR EQUAL
Sink			720C, 720G, 720I		
Faucet	F-15	F-15	F-15	F-15	
Strainer	K-8801	4331.013		6457	

ST-4: Same as ST-3, except with flat strainer and deck mounted faucet.

(To be specified for Art Classroom, Shop and Industrial Craft rooms, Ceramic, Science Room - replacement only, and Special Education Classrooms.)

Strainer	KOHLER K-8807	CHICAGO	HAWS 6455	AMERICAN STANDARD 4311.023	OR EQUAL
Faucet	F-10	F-10	F-10	F-10	

ST-5: Cast Iron, 18-inch by 12-inch; 24-inch by 18-inch; or 30-inch by 18-inch **(Designer to select and specify the size)** or as indicated on drawings, with flat rim and center outlet. Single compartment, with basket strainer, hot and cold wall mounted CP faucet.

(To be specified for use in Administration Offices, Conference Rooms, Teacher Workrooms, faculty Lounge, Library, and Kiln room.)

	KOHLER	AMERICAN STANDARD	CECO	HAWS	OR EQUAL
Sink			720-C, 720-G, 720-I		
Faucet	F-14	F-14	F-14	F-14	
Strainer	K-8801	4331.013		6457	

ST-6: Same as ST-5, except with wall mounted faucet and flat strainer.

(To be specified for use in Art Classroom, Shop and Industrial Craft Rooms, Ceramic, Science Room - replacement only, and Special Education Classrooms.)

KOHLER	AMERICAN STANDARD	ELKAY	OR EQUAL
Strainer: K-8807	4311.023	LK18	

ST-7 Cast Iron, 32-inch by 21-inch double compartment ledge, with hot and cold faucet, garbage disposal unit in locations indicated on drawings, basket strainer in all other

locations. Division tees to be furnished on two part waste connected to garbage disposals.

(To be specified for use in Homemaking and Multi-Purpose Rooms.)

	AMERICAN STANDARD	KOHLER	ZURN	OR EQUAL

Sink	7045.804	K-5950-3		
Faucet	F-6	F-6	F-6	
Strainer	433.012	K-8801		

ST-8: Same as SS-1 – (See Section 2.28 – Service Sinks) 24-inch by 18-inch by 6-inch single compartment roll rim with back.

(To be specified for use in Boiler and Equipment Rooms.)

	AMERICAN STANDARD	CECO	KOHLER	ZURN	OR EQUAL
Sink		867	K-6714-18	Z5880	
Faucet	F-1 (See Article 2.13 – Faucets)	F-1	F-1	F-1	
Trap Standard		870-2	K-6672		

ST-9: Vitreous China, Clinic service sink, wall hung blowout action, flush valve, hot and cold faucet, rim guard and carrier fitting.

(To be specified for use in Boiler and Equipment Rooms.)

	AMERICAN STANDARD	CRANE	KOHLER	J.R. Smith	OR EQU AL
Sink	9512.013	7H-544	K-12867	K-5980	
Faucet	F-12	F-12	F-12	F-12	
Flush Valve	Sloan 117H	Sloan 117	Sloan 117		
Wall hung carrier				0913, 0914, 0915	

ST-10: Cast Iron 48-inch by 18-inch Shop Classroom trough sink with two double faucets and a drinking bubbler mounted on right-hand side of backsplash, complete with hangers. Sink shall be acid-resistant enamel.

(To be specified for use in Industrial Arts/Crafts and Ceramic rooms.)

	KOHLER	HAWS	CECO	OR EQUAL
Sink	K-3202		204	
Faucet	F-11	F-11	F-11	
Strainer	K-8820			
Drinking Bubbler				

2.30 SEWAGE EJECTORS

A. Schedule Numbers:

SE-1: Duplex, (unless otherwise indicated) screen-less sewage ejector with two pumps and motors mounted on cover-plate and cover-plate shall be gas tight; furnished with automatic alternator, high water alarm, micro switch liquid level controller starters, fused disconnect switches and factory wired. Sump pit concrete is as specified in a related section.

WEIL CO.	PUMP	PACIFIC PUMP CO.	Mc PUMP CO.	COOK PUMP	HYDROMATIC PUMP	OR EQUAL

2. Motors: Drip-proof with electrical characteristics as scheduled on Drawings.
3. Controls: Weil Model 8230, or equal, mercury float switches, UL listed, two switches for high water alarms with cover mounting brackets. Control panels shall be NEMA 1, UL listed, and each contain following:
 - a. Two cross-the-line magnetic starters.
 - b. Two fusible disconnect switches.
 - c. Two HOA switches.
 - d. Two running lights.
 - e. One 480/220 volt control circuit transformer.
 - f. One high water alarm relay.
 - g. One alternator.
 - h. One NEMA 1, 4-inch diameter alarm bell for mounting on control panel.
4. Basin Covers: Heavy steel covers, sizes as scheduled on drawings. Covers shall be duplex type with openings for pumps, manholes, and vent openings. Parts shall be gas-tight.

2.31 SERVICE STOP GAS VALVES

A. Schedule Numbers:

SGV-1: Bronze/Brass gas cock valve with double stake packing nut, ½ inch to 2-inch, with IPS, inclusive, with flat or square head. CSA approved.

(To be specified for oven ranges, convection ovens, skillets.)

AMERICAN	Mc DONALD	NIBCO	OR EQUAL
85 CBK or 86C	10596, flat 10604, square	GB2A	

SGV-2: Bronze/Brass, ¾-inches to 2-inch IPS (WOG) water, oil, or gas – full port ball valve. CSA approved.

(To be specified for larger water heaters, small boilers, pool heaters, and A/C units on roofs.)

WATTS	NIBCO	WILKINS	OR EQUAL
LFFBV-4	F-510-CS-R-66-FS	Model 850	

SGV-3: Cast iron, 2-inch to 4-inch flanged ball valves (WOG) water, oil, or gas. CSA approved.

(To be specified for larger heating equipment.)

WILKINS	NIBCO	WATTS	OR EQUAL
Model 850	F-510-CS-R-66-FS	G4000M1	

SGV-4: Lubricated plug gas valve, 3/4-inch to 2-inch IPS valve.

To be specified for use after gas meter headers, gas regulators, and isolation valves for building isolation, individual floor level isolation, and boiler rooms.)

NORDSTROM	WALWORTH	RESUN	OR EQUAL
142	1786	1430	

SGV-5: Lubricated plug gas valve flanged type 2 ½-inch and larger valve.

(To be specified for use after gas meter headers, gas regulators, isolation valves for buildings isolation, individual floor level isolation and boiler rooms.)

NORDSTROM	WALWORTH	RESUN	OR EQUAL
142	1786-F	1431	

SGV-6: Bronze/Brass ½-inches to 2-inch IPS with lever handle full port ball valve (WOG) water, oil, or gas, CSA Approved.

(To be specified for use in Science, Home Economics, Physics, Biology, physiology, and Modern Science work rooms behind access panel.)

RFD and WHITE	NIBCO	WILKINS	OR EQUAL
Fig. 5544	T-585-70-UL	Model 80	

SGV-7: Bronze/Brass ½ inch to 2-inch IPS X Flare Appliance ball valves with Tee handle. Flares to be used in conjunction with corrugated flex lines.

(To be specified for clothes dryer, water heaters, unit heaters, and wall heaters up to 100,000 BTU.)

RED and WHITE	BRASSCRAFT	NIBCO	OR EQUAL
RW 5210	TBV 10-12	GBV 12	
RW 5211	TBV 8-8	GBV 1516	
RW 5221	TBV 6-8		

2.32 SUMP PUMP

A. Schedule Numbers:

SP-1: Duplex, centrifugal open type impeller and motor mounted cover plated, furnished complete with high water alarm, automatic alternator, float switch, enamel control panel, with starters, disconnect switches, pilot lights, factory wired, sump pit shall be concrete **(or fiberglass)** as specified in a related section.

WEIL PUMP CO.	PACIFIC PUMPING CO	Mc COOK PUMP CO.	HYDROMATIC PUMP	OR EQUAL
1600 Series				

2.33 STOP VALVES

A. Stops shall be loose key type, ½-inches IPS inlet and outlet chrome-plated brass casting, except as noted.

B. Schedule Numbers:

STV-1: Angle:

CHICAGO,	BRASSCRAFT	NIBCO	OR EQUAL
442-LKABCP		77	

STV-2: Partition:

CHICAGO	T & S BRASS	OR EQUAL
1771-ABCP	B-1028	

STV-3: Straight Type, with Loose Key:

CHICAGO	BRASSCRAFT	T&S BRASS	OR EQUAL
45-LKABCP (1/2 inch)		B-O418	

2.34 THERMOSTATIC MIXING VALVE ASSEMBLIES (TMVA)

A. General: Valve bodies shall be cast brass or bronze valve assembly provided with holding bracket and shall be installed on wall bracket. Valve shall be rough brass or

bronze satin sprayed finish unless otherwise noted. Assembly shall include a 3 5/8-inch diameter dial thermometer, color-coded with white face and black letters. The temperature range between 100 degrees F. and 150 degrees F. shall be background in red or red line enclosed. Valve complete with fail safe feature, square shank loose key stops, checks and strainers on both hot and cold-water inlets and shutoff valve on outlet. Valves shall be sized on a 45 psig (maximum) pressure drop at the following flow rates:

TMVA-1:5 to 15 GPM.

TMVA-2:25 GPM.

TMVA-3:40 GPM.

TMVA-4:60 GPM.

TMVA-5:80 GPM.

TMVA-6:100 GPM.

TMVA-7:125 GPM.

TMVA-8:200 GPM.

B. Manufacturers:

POWERS	T & S	LEONARD	BRADLEY	WATTS	OR EQUAL
Type 430 Series Single Valve Hi-Lo (1430 series)	Ultra- Safe	Type TM	Navigator High/Low	Series LFMMV	

2.35 TRAP PRIMERS

A. Schedule Numbers:

ATP-1: Automatic, multi-trap primer, cast bronze with access panel. Pressure drop of three p.s.i. shall activate trap seal primers. Manufactured by MIFAB, or equal. (Installed in accessible location.)

MIFAB	OR EQUAL
MR-500-NPB	

2.36 URINALS

A. Schedule Numbers:

U-1: Non-water urinal. Wall-hung vitreous china with replaceable trap cartridge or integral liquid seal trap, provided with a biodegradable liquid seal in compliance with the California Building Code and maintains a sanitary and odor-free environment. Furnish complete with hanger brackets, fasteners, gaskets and drain line connections.

WATERLESS	ZURN	FALCON/SLOAN	KOHLER *	ZERO FLUSH	OR EQUAL
YUKON 2101	Z5795	F1000/ WES-100	K-4919	ZF101	

* Not for kindergarten application

1. Fixtures shall comply with the following requirements:
 - a. Current versions of ASME A112.19.19, standard for Vitreous China Non-Water Urinals and/or IAPMO IGC 161.
 - b. Shall meet performance, testing, and labeling requirements for American National Standards Institute (ANSI).
 - c. Non-water urinals shall hold a current certificate of listing with IAPMO, and shall bear the C/IAPMO triangular certification and shall be manufactured in compliance with current IAPMO IGC 161.
2. Trap shall permit the uninhibited flow of waste through the Urinal to the sanitary drainage system.
3. Manufacturers must have a current Los Angeles Unified School District Office of Environmental Health and Safety MSDS approval prior to submittal. The following chemical compounds are currently approved:
 - a. Falcon Waterfree Sealant.
 - b. Waterless Co. Blue Seal Liquid.
 - c. Zurn Aqua Green Sealant.
 - d. Kohler Waterless Urinal Sealing Liquid.
 - e. Zero Flush Odor Barrier Liquid.
4. Urinals shall at time of school opening be serviced by replacing with an entirely new cartridge and liquid sealant, for units with removable cartridges. All urinals with built in traps shall be rinsed out and liquid sealant replaced.
5. Provide the following replacement quantity based on manufacturer's annual maintenance requirements for each urinal fixture installed:
 - a. Falcon Waterfree, four cartridges with liquid trap sealant

- b. Waterless Co., four cartridges and 78 ounces of liquid trap sealant.
 - c. Zurn Waterless, 36 ounces of liquid trap sealant.
 - d. Zero Flush, two drain inserts and 24 ounces of liquid trap sealant.
 - e. Kohler Waterless, 78 ounces of liquid trap sealant.
- 6. Training shall consist of two hours of manufacturer certified training for all site-based operations personnel prior to school occupancy. Certificates shall be issued for all personnel who attend the original training session. The plant manager shall be certified as a trainer by the manufacturer. Provide two video tape copies of the original training session.
 - 7. Provide a manufactured supplied "non-water urinal" descriptive placard at each urinal. Mounting heights shall be 48-inch for standard urinals and 42-inch for access compliant urinals.
 - 8. Provide chrome brass flange and chrome brass I.P.S. cap to each urinal water supply line.
 - 9. Provide accessible clean-out above each urinal.
 - U-2: Same as U-1 with fixture roughed-in at access compliant height.
 - U-3: Low flush urinal, 1/8 gallon. Wall-hung vitreous china, furnish complete with hanger brackets, fasteners, gaskets and 3/4-inch top spud.

B. Bowl:

AMERICAN STANDARD	SLOAN	ZURN	OR EQUAL
6590.001	SU-1009-STG	Z5755-U	

C. Auto-flush valve (battery): FLV-2.

D. Manual-flush valve: FLV-2a.

U-4: Same as U-3 with fixture roughed-in at access compliant height.

2.37 WATER CLOSETS

A. General: Water closets shall be vitreous china with Polyvinyl chloride bolt caps. Fixtures with auto-flush valves shall be provided with manual override button.

B. Schedule Numbers:

WC-1: Floor-mounted, 14 to 15 inch high bowl for Elementary students. Use with flush valve at 1.28 gallons per flush and open front fire retardant white seats, less cover.
(To be specified for Elementary School uses. Non- accessible)

a. Bowl:

AMERICAN STANDARD	KOHLER	SLOAN	ZURN	OR EQUAL
3451.001	K-96053	ST-2009	Z5655-BWL1	

b. Auto-flush valve (battery): FLV-1.

c. Manual-flush valve: FLV-1a.

d. Seat: White, ring thickness including bumpers shall be one inch.

OLSONITE	BEMIS	CENTOCO	OR EQUAL
10SSCTFR	1955 SSFR	AMFR500STSCSS	

WC-2: Floor-mounted, 15 inches height to top of seat for Elementary student use, access compliant, with flush valve at 1.28 gallons per flush and open front fire retardant white seats, less cover.

(To be specified for Elementary School uses. Access compliant)

a. Bowl:

AMERICAN STANDARD	ZURN	OR EQUAL
2599.001	Z5654 BWL	

b. Auto-flush valve (battery): FLV-1.

c. Manual-flush valve: FLV-1a.

d. Seat: White, ring thickness including bumpers shall be one inch.

OLSONITE	BEMIS	CENTOCO	OR EQUAL
10SSCTFR	1955 SSFR	AMFR500STSCSS	

WC-3: Floor-mounted, 15 to 17 inches height to top of seat for secondary school students and adult use, with flush valve at 1.28 gallons per flush and open front fire retardant white seats.

(To be specified for non-accessible use for Secondary School students and adults use)

a. Bowl:

AMERICAN STANDARD	KOHLER	SLOAN	ZURN	OR EQUAL
3451.001	K-96053	ST-2009	Z5655-BWL1	

- b. Auto-flush valve (battery): FLV-1.
- c. Manual-flush valve: FLV-1a.
- d. Seat: White, ring thickness including bumpers shall be one inch.

OLSONITE	BEMIS	CENTOCO	OR EQUAL
10SSCTFR	1955 SSFR	AMFR500STSCCSS	

WC-4: Floor mounted, access compliant, 17 to 19 inches height to top of seat with flush valve at 1.28 gallons per flush and open front, fire retardant seat.

(To be specified for access compliant use in Secondary schools for students and adults use.)

- a. Bowl:

AMERICAN STANDARD	KOHLER	SLOAN	ZURN	OR EQUAL
3461.001	K-96057	ST-2029	Z5665-BWL-1	

- b. Auto-flush valve (battery): FLV-1.
- c. Manual-flush valve: FLV-1a.
- d. Seat: White, ring thickness including bumpers shall be one inch.

OLSONITE	BEMIS	CENTOCO	OR EQUAL
10SSCTFR	1955 SSFR	AMFR500STSCCSS	

WC-5: Floor mounted, 11 to 12 inches height to top of seat with flush valve at 1.28 gallons per flush and open front fire-retardant white seats.

(To be specified for Kindergarten age and younger users.)

- a. Bowl:

AMERICAN STANDARD	ZURN	Kohler	OR EQUAL
2282.001	Z-5675-BWL	K-96064	

- b. Auto-flush valve (battery): FLV-1.
- c. Manual-flush valve: FLV-1a.
- d. Seat: White, ring thickness including bumpers shall be 1-1/4 inch.

BEMIS	OR EQUAL
BB 955 CT	

WC-6: Wall-hung, with 1.28 gallon/per flush, flush valve and open front fire retardant seat in white, less cover.

(To be specified for use when floor-mounted water closet piping interferes with flooring and inverted elevation is too critical to make connection. Specify Installation at appropriate height for application – see Section 2.47 “Height of Fixtures”).

a. Bowl:

AMERICAN STANDARD	KOHLER	SLOAN	ZURN	OR EQUAL
3351.101	K-4325	ST-2459	Z5615-BWL	

b. Auto-flush valve (battery): FLV-1.

c. Manual-flush valve: FLV-1a.

d. Seat: White, ring thickness including bumpers shall be one inch.

OLSONITE	BEMIS	CENTOCO	OR EQUAL
1055CTFR	1955 SSFR	AMFR500STSCCSS	

2.38 WATER TEMPERATURE CONTROLLERS

A. Schedule Numbers:

WTC-1: Remote bulb type, plain steel case, baked enamel finish, glass fronted cover, mercury to mercury switch. 80 degrees F. to 240 degrees F. range of not more than 10 degrees F. differential.

MERCOID	HONEYWELL	JOHNSON CONTROLS	OR EQUAL
DA-4-35	T675A1540	A19 SERIES	

WTC-2: Immersion type, black hard steel case, separate well type, outside adjustment, temperature range 40 degrees to 180 degrees F. range of not more than 10 degrees F. differential.

HONEYWELL	PENN	JOHNSON CONTROLS	OR EQUAL
T-6031D 1007	A19ABC-11	A19 SERIES	

2.39 WATER HEATERS / DOMESTIC BOILERS

A. Gas fired water heaters shall meet the Flammable Vapors Ignition Resistance requirements (FVIR).

B. Gas and electric water heaters must meet NAECA energy efficiency requirements. Exceptions: Table top and point of use models (electric) less than 20 gallons. In capacity and gas models over 75,000 BTUH.

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- C. Water heaters from 75,000 BTU/hr to Boilers 2,000,000 BTU/hr shall comply with rule 1146.2 "Emission of Nitrogen from large water heaters and small boilers". Natural gas fired water heaters with heat input rates less than 75,000 Btu/hr shall comply with rule 1121.
 - D. Schedule Numbers:
- WH-1: Storage type water heaters shall be provided with a five year unconditional guarantee on tank heater and working parts. Complete guarantee for each heater shall be delivered to the Owner's Authorized Representative (OAR).
- a. Heater shall be furnished complete with baked enamel jacket, double density insulation, heating device, energy saver thermostat, drain valve is to be a ball valve with a plug in one end, and appurtenances necessary for satisfactory operation. Proper label of approval and manufacturer name, model number, size in gallons, and rated capacity shall be permanently secured to jacket.
 - b. Heater shall be furnished with a combination pressure temperature relief valve, installed in water heater tank.
 - c. Heaters, gas and electric, shall be certified by the California Energy Commission.
 - d. Floor-mounted heaters shall be on legs that are part of heater. Each heater shall be securely strapped to structure (with 2 straps per code).
 - e. Electric water heaters shall be UL tested, approved and listed. Heaters shall be furnished complete with baked enamel jacket, glass fiber insulation, heating element, double break snap acting thermostat, drain valve and appurtenances required for operation. Electric heaters shall be factory wired ready for connection to electrical source. Install a gate valve on inlet side and union on both inlet and outlet sides of heaters and combination pressure-temperature relief valve on discharge side. Flexible water piping connectors shall not be used.
 - f. Water heaters shall be of sizes indicated on Drawings and shall be furnished with equipment necessary to provide a complete and satisfactory piece of equipment.
 - g. Submit a complete list of boiler controls and appurtenances with wiring diagram, giving manufacturer's name, model number and, when applicable, size of each piece of equipment or appurtenance to be installed.
 - h. Pilot lines, gas valves, relays and their wiring shall be located outside boiler jacket to protect them from ambient temperature within. Flame safeguard relay shall be mounted on a control panel attached to wall at location

indicated or as directed. All other controls and manual operators shall be so located as to be readily accessible when the boiler is in the installed position.

- i. Wiring of water pump control circuit and line voltage supply to control panel is part of the Work of Division 23. All other wiring in connection with boilers is a part of the Work of this section. Wiring between boiler and wall-mounted control panel shall be installed 7 feet or more above floor level.
- j. Gas-fired, storage type, size indicated on Drawings, with draft diverter and energy cut-off devices. Gas supply connections supplying less than 100,000 BTUs shall be with UL listed corrugated flexible appliance connector, and comply with ANSI Z21.24/CSA 6.10, Connectors for Gas Appliances. Connections supplying 100,000 BTUs and over shall be solid pipe. Heater shall be seismically secured with an approved restraint. HOLDRITE QS-50, QS-120.

Model No. as indicated on drawings or equal by:

AMERICAN	BOCK	RHEEM	A.O. SMITH	BRADFORD WHITE	OR EQUAL

WH-2: Commercial, high recovery, greater than 80 percent thermal efficiency.

WH-3 Water Heater, Package Water Tube, Gas-Fired Type:

- a. Complete packaged unit furnished with heater, burner, pre-cast firebox, insulation, steel jacket enamel both sides, trim and control factory wired. This gas-fired water tube heater shall be constructed in accordance with the ASME Code for 125 psi working pressure and bear appropriate seal. Heater shall be AGA approved and stamped for natural gas at 80 percent efficiency.
- b. Heater shall be of inclined or straight tube design for high velocity water flow with not greater than one inch outside diameter hard drawn copper tubes of minimum 13 gage thickness. Heater head plates shall be removable, to provide full access to boiler tubes.
- c. Complete heater shall be fire tested at the factory under design load conditions with results certified by an approved testing agency satisfactory to the AOR.
- d. Heater shall be complete with accessories and appurtenances including AGA approved draft diverter, safety, relief valve or valves SRV-4 lever handle gas cock on main gas line FGV-8, gas pressure regulator PRV-4 set for 4-inch water column, automatic 24 volt gas valve FGV-1, a lever handle gas cock FGV-8 and pressure regulator PRV-4 set for 4-inch water column on pilot line; safety pilot assembly BTPA-1 or BTPA-2 (heaters over 150,000 BTU per hour), operating temperature controller OTC-1; high limit

temperature controller HTC-1; control transformer Cont-1; 2 thermometers T-1. Refer to Section 23 5000: Heat Generation Equipment, for above accessories.

LAARS	AJAX	RAYPACK	A.O. SMITH	LOCHINVAR OR EQUAL

WH-4: Electrical, storage type, size as indicated on Drawings. Tank shall be constructed of galvanized copper-bearing steel and shall be tested at 300 lb. hydraulic pressure. Heater shall be factory wired ready for connection to electrical source. Snap acting thermostat shall be double pole type. Heater label shall be labeled UL approval and electric input rating. Heater shall be seismically secured and shall not be floor-mounted.

RUUD	A.O. SMITH	AMERICAN	OR EQUAL
EGSP	ELJF – 6S	LDCE31-06U	
	DEL-6	LDCE31-12U	

WH-5: Tank-less instantaneous electric water heaters: Comply with UL 499 for tank-less electric (water heater) heating appliance. Comply with ANSI/NSF 372. Provide a five-year limited leak warranty, covering one year of replacement parts. Electric tank-less water heater shall have a maximum operating pressure of 150 PSI. Heater shall be furnished complete with a UL rated cover with manufacturer name and model number permanently secured to the unit. Heating element shall be a replaceable cartridge insert. Unit must turn on at a minimum flow of 0.25 gpm. Provide isolation valves before and after water heater. Provide external or internal thermostatic mixing valve. Provide separate electrical power circuit breaker.

Eemax	OR EQUAL

2.40 WATER HAMMER ARRESTORS

WHA-1: Lead Free Water Hammer Arrestor provided for Headers for Lavatories, Wash Sinks, Wash Fountains, Kitchen Sinks, Service Sinks, Urinals and Water Closets. For sizing purposes size according to manufacturer's recommendations.

SIOUX CHIEF	PPP	JR SMITH	WATTS	JOSAM	OR EQUAL
655 and 656 SERIES	SC SERIES	5005 TO 5050 SERIES	Series LF05 and LF15M2	75000	

2.41 WATER TANKS, HOT – UNFIRED

A. Schedule Numbers:

- WT-1 Unfired Hot Water Storage Tanks: All welded 1/2 inch thick hot rolled carbon steel plate construction conforming to requirements of ASME Code for Unfired Pressure Vessels (Section VIII of ASME Boiler and Pressure Vessel Code). Tank designed for a working pressure of 125 psig and temperature of 150 degrees F.; tested and coded stamped. Connections shall be 3,000 psi welded extra heavy couplings. Flanged coupling may be furnished on 3 inches or larger connections.

ACE BUEHLER	RAYPAK	A.O. SMITH	OR EQUAL
	LOCHINVAR	BRADFORD/WHITE	

- WT-2 Steam-Heated Hot Water Storage Tanks: Same as WT-1, but with addition of heating elements. Heating elements of seamless drawn copper tubing (3/4 inch outside diameter or 1 1/4-inch outside diameter).

ACE BUEHLER	RAYPAK	A.O. SMITH	OR EQUAL

- WT-1L: Same as WT-1, but thickness as required by ASME Code for size specified; furnished with not less than 5/8 inch silicon material lining. Lining shall extend into openings so no ferrous metal remains uncovered. Lining shall be guaranteed in writing for a period of 5 years.

- WT-2L: Same as WT-2, except lining same as for WT-1L.

2.42 YARD BOXES

- A. Schedule Numbers:

- YB-1 Yard Boxes: 14 3/4-inch by 20-inch by 12-inch, cast concrete, with cast iron hinged locking traffic cover marked "GAS"

(For use over gas stops for portable buildings only, on addition to accessible emergency shutoff valve on building.)

BROOKS No. 36-HFL Assembly with cast iron hinged locking cover	OR EQUAL

- YB-2: Same as YB-1, marked "WATER" **(For use over water valves).**

BROOKS No. 36-HFL Assembly with cast iron hinged locking cover	OR EQUAL

- YB-3: Same as YB-1, marked "SEWER"

BROOKS No. 36-HFL Assembly with cast iron hinged locking cover	OR EQUAL

2.43 FIXTURE CONNECTIONS

- A. Branches to individual fixtures shall be of the following sizes (Inches) unless larger sizes are indicated on Drawings:

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Fixture	Copper, Cold (Inches)	Copper, Hot (Inches)	Trap and Connections (Inches)	Soil/ Waste (Inches)	Vent (Inches)
WC Flush Valve	1	N/A	4	4	2
Lavatories	1/2	1/2	1-1/2 by 1-1/4	2	1-1/2
Service Sink	1/2	1/2	2	2	1-1/2
Kitchen Sink	1/2	1/2	1-1/2 by 1-1/2	2	1-1/2
Classroom Sink	3/8	3/8	1-1/2 by 1-1/2	2	1-1/2
Wash Sink	3/4	1/2	1-1/2 by 1-1/2	2	1-1/2
Multiple Drinking Fountains		N/A	1-1/2 by 1-1/2	2	1-1/2
Single Drinking Fountains	3/8	N/A	1-1/2	2	1-1/2
Individual Showers		1/2	2	2	2
Standard Urinals, Wall-Hung Flush Valve:		N/A	N/A	2	1-1/2
Access Compliant Urinals, Wall-Hung Flush Valve:		N/A	N/A	2	1-1/2
Sillcocks	3/4 minimum	N/A	N/A	N/A	N/A

- B. Water headers serving water closets shall be copper water tube, with following size throughout length:

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1. 1-1/2 inches for 2 flush valves.
 2. 2 inches for 3 to 9 flush valves.
- C. Water headers serving urinals shall be of following size throughout length:
1. 1" for 1 or 2 flush valves.
 2. 1-1/4" for 3 flush valves.
 3. 1-1/2" for 4 to 8 flush valves.
- D. Water headers serving showers shall be same as listed above for urinals.
- E. Water headers serving lavatories shall be of following size throughout length:
1. 1/2 inch for 2 lavatories.
 2. 3/4 inch for 3 and 4 lavatories.
 3. One inch for 5 and 6 lavatories.
 4. Refer to 2.02.E for fixture supplies.

2.44 HEIGHT OF FIXTURES

- A. Heights for standard fixtures.

Fixture	Adult and High School (Inches)	Secondary (Inches)	Elementary (Inches)	Kindergarten and Younger (Inches)
Toilets, height to top of seat	15 to 17	15 to 17	15	11 to 12
Lavatories, sink top height	32	32	30	25
Drinking Fountains, bubbler height.	38 to 43	40	32	30
Wash Sinks	30	30	28	24
Urinals, lip height	24	21	18	N/A

Shower Heads Male (Student and Instructor) From tip of shower head to finish floor.	72	60		
Shower Heads Female (Student and Instructor) From tip of shower head to finish floor.	72	60		
Shower valves	48	48		

B. Heights for access compliant fixtures.

Fixture	Adult Ages 12 and Over (Inches)	Elementary Ages 6 to 11 (Inches)	Kindergarten and Younger Ages 3 to 5 (Inches)
Toilets, center line from wall	17 to 18	15	12
Toilets, height to top of seat	17 to 19	15	11 to 12
Lavatories, sink top height	34 maximum	29 maximum	24 maximum
Lavatories, sink knee clearance	27 minimum	24 minimum	19 minimum
Urinals, lip height	17 maximum	15 maximum	13 minimum
Urinals, flush handle height	44 maximum	37 maximum	32 maximum
Drinking fountains, bubbler height.	36 maximum	32 maximum	30 maximum
Drinking fountains, knee clearance	27 minimum	24 minimum	22 minimum

Wash Sink	Per Drawings		
Shower Valves	Per CBC		
Shower Seat	Per CBC	Per CBC	Per CBC
Shower Head (adjustable) Bar	Per CBC		

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which Work of this section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General:
 - 1. Unless otherwise specified, plumbing fixtures, equipment and appliances that require connections to plumbing line shall be connected. This shall include fixtures specified or indicated as furnished by others, furnished by Owner, or specified in other related sections. Install supplies, stops, valves, traps, wall flanges, or pipe casing for connection of this equipment.
 - 2. Install equipment as indicated on reviewed and accepted Shop Drawings.
 - 3. Avoid interference with Work of other trades. Do not deviate from Drawings without review of the Architect.
- B. Examination: Check each piece of equipment in system for defects verifying that parts are properly furnished and installed.
- C. For piping Work, refer to Section 22 0513: Basic Plumbing Materials and Methods.
- D. Plumbing Fixture and Equipment Installation:
 - 1. Unless otherwise indicated, fixtures shall be installed with 5/16 inch brass bolts or screws of sufficient length to securely fasten fixture to backing, wall, or closet ring.

2. Fixtures installed against concrete or masonry walls shall have their hangers fastened with 5/16 inch brass bolts, Philip Shield type anchors, or 2 unit cinch anchors. Wood or plastic plugs are not permitted.
3. Fixtures installed against wood or metal stud walls shall have their hangers fastened to metal backing plates with 5/16 inch brass bolts screwed into plate. Fixture hangers for urinals shall be fastened centered vertically on metal backing plate with three 5/16 brass bolts each for small individual hangers and six, for larger one piece hangers. Lavatories shall be hung with not less than four 5/16 inch brass bolts or not less than five 1/4 inch brass bolts. Each sink hanger shall be hung with not less than four 5/16 inch brass bolt or not less than five 1/4 inch brass bolts.
4. Pan type drinking fountains shall be hung with 5/16 inch cadmium plated bolts with a bolt in each bolt opening in hanger. Hangers for pan type drinking fountains shall provide 2 inches (plus or minus 1/4 inch) between pan and wall. Spaces due to irregularities between fixtures and tile walls shall be neatly filled with white cement or silicone filler.
5. Backing for hanging of plumbing fixtures and equipment shall be installed in supporting wall at time rough piping is installed. Backing for stud walls shall be steel plate 1/4 inch thick, not less than 4 inches wide. Backing for urinals shall be 1/4-inches thick by 6-inch wide steel plate. Steel plate shall be attached to stud at each end of plate and to each stud it crosses. Plate shall be attached to metal studs by bolting with two 1/4 inch U-bolts per stud with bolts through plate and around stud flange or by welding with a 1/8 inch fillet weld full width of stud flange, top and bottom of plate. At wood studs, plate shall be carefully recessed flush with face of stud and attached to each stud with 2 No. 14 flat-head wood screws, 2 inches in length into pre-drilled 1/8 inch holes. Backing for stud walls supporting wall-hung closets shall be as detailed.
6. Rough-in for fixtures, equipment and appliances shall be as indicated on Drawings and as specified, including those items indicated as furnished by others, furnished by Owner, or future capacity. When connections to equipment from capped or plugged lines are required, caps or plugs shall be removed at time equipment is set and stops or valves installed and connections provided as specified.
7. Piping materials for trap arms shall be Brass, Cast Iron or DWV copper
8. Piping shall be stubbed out to exact location of fixtures and stubs shall be installed symmetrical with fixtures. Hot and cold water supplies for center set faucets on lavatories shall be installed on 8-inch centers, unless otherwise specified or required.
9. Kitchen equipment requiring backflow protection with hot and cold water connections shall be installed with approved backflow prevention assemblies; BPV-3 and drain into floor sink with air gap.

E. Cleanouts in Drain, Waste, Vent and Sewer Lines:

1. Cleanouts shall be installed at locations stated in the California Plumbing Code and accessible at following locations:
 - a. At locations above first floor as stated on construction documents and 5 feet outside of the building.
 - b. Install an accessible main line upper terminal cleanout in all restrooms above water closet over flow. (Install above upper terminal water closet where there are more than one water closet in a restroom).
 - c. Above faucets of each sink with brass plug.
 - d. Above service sink with brass plug.
 - e. At each Drinking Fountain with brass plug.
 - f. At each urinal and locate above urinal with brass plug.
 - g. Above overflow level of pot sinks with brass plug.
 - h. In vertical line at base of each downspout connected to an underground storm drain system extend cleanout to exterior of building.
 - i. At upper end of a horizontal vent line when any part of horizontal line is below overflow level of fixture it serves.
 - j. Not to exceed 100-foot intervals in sewer and waste lines exterior of building.
 - k. At property line connection.
 - l. Where indicated on Drawings.
2. Cleanouts shall be extended to grade as follows:
 - a. Not to exceed 100-foot intervals in straight runs of pipe outside buildings.
 - b. At horizontal changes of direction in aggregate greater than 135 degrees (underground).
 - c. At property lines.
 - d. Where cleanouts occur under concrete.

- e. Where marked for future connections.
3. Cleanouts in building shall be extended to floor level or above floor level or above floor level in walls or furring when cleanouts are not accessible or where clearance is less than 18 inches.
 4. Cleanouts in finished areas in building shall be concealed except that cleanouts above service sinks in janitor's rooms or closet, and cleanouts above service sinks or in exposed piping in boiler or heater equipment rooms, may be exposed. Cleanouts for urinals shall be installed above urinal and shall terminate behind an access plate.
 5. Cleanouts in floors of covered areas and those extended to grade in concrete areas shall be floor level type with extensions body brass plugs and detachable nickel-bronze or aluminum alloy scoriated.
 6. Concealed cleanouts in vertical lines shall be service weight soil cleanout tees with brass plugs and round cover plates unless otherwise specified or indicated. A snug fitting sleeve of galvanized sheet metal shall be placed around hub of tee and shall extend to flush with finished soil, or cleanout shall be extended to finished wall.
 7. Cleanouts extended from below floor to a wall or furring or on horizontal lines above floor that terminate at a wall or furring shall be iron body type with brass plugs and round cover plates.
 8. Cover plates over cleanouts in painted walls shall be steel, bonderized and prime coated. Cover plates cover cleanouts in tile walls shall be chromium-plated brass or nickel bronze. Plates shall be attached to cleanout plugs with 5/16 inch No. 18 or 1/4 inch No. 20 stainless steel vandal-proof type screws. Plates shall be one inch larger in diameter than fitting opening.
 9. Cleanouts at bases of downspouts shall be tapped soil tees with brass plugs as hereinafter specified, full size of line.
 10. Cleanouts extended to grade in exterior sewer lines other than floors or concrete areas shall be a cleanout assembly with secured top, extra heavy-duty, adjustable sleeve, cut-off ferrule, countersunk threaded brass plug and scoriated tractor type cover.
 11. Other cleanouts shall be iron body type.
 12. Cleanout extensions shall be no-hub cast iron soil pipe. Exterior cleanouts, those in concrete excepted, shall terminate in a 14-inch by 6-inch thick concrete block with cleanout assembly and top of block flush with finish grade.
 13. Fittings in lines utilized as cleanouts shall be approved soil fittings including no-hub pipe. Tees and crosses in vent headers excepted.

14. Pipe joint compound shall not be installed on cleanout plug. After lines are tested and approved, each cleanout plug shall be removed, greased, and replaced.

3.03 EXCAVATION, TRENCHING AND BACKFILLING

- A. Perform trenching, excavation, and backfilling required for Work of this section as specified herein and in Section 31 2323: Excavating, Backfilling, and Compacting for Utilities.

3.04 SERVICE CONNECTIONS

- A. Determine exact location of required water, drain, and sewer connections and provide proper connections.
- B. Potable water lines shall be purged completely before connecting to sources of water for the Project. Determine quality of water supply before connection.

3.05 WATER HAMMER ARRESTORS

- A. Install water hammer arrestors indicated on Drawings and in following locations (only non-ferrous arrestors may be installed in copper water system):
 1. Water lines to lavatory headers, water closet and urinal headers, service sinks, kitchen sinks, wash fountains, drinking fountains, laboratories with medical type faucets and on wash sinks having three or more stations and all other quick closing fixture such as clothes washers, as close to fixture as possible.
 2. Between last two fixtures when three or more fixtures, other than those listed in Number 1 above, are served by a common header.
- B. When possible, arrestor shall be installed in wall or furring. When arrestor is installed in wall or furring, furnish an access plate large enough to permit removal of arrestor. Access plate shall be a minimum of 2 inches larger in each direction than the arrestor.
- C. Fixture water lines shall be provided with mechanical water arrestor hammer dampening devices. Air chambers are not approved.

3.06 CONDENSATE DRAINS - FROM AIR CONDITIONING UNITS

- A. Connect drain piping from drain pan of air conditioning unit to condensate disposal location indicated. When coil or unit housing is shock or vibration isolated,

connection shall be furnished through a flexible connector not less than 10 inches long. Drain line shall pitch to flow out at not less than one inch in 8 feet. Drain line shall not be reduced smaller than unit outlet connection.

- B. Condensate drain piping installed within building whether in air conditioned space or not shall be insulated. Refer to Section 22 0700: Plumbing Insulation, for type of material required.
- C. Condensate Trap:
 - 1. A condensate trap shall be installed for each air conditioning coil. Trap shall be assembled from 2 brass unions: one between A/C unit and inlet of trap, and one at outlet of trap that connects to main drain.
 - 2. Trap configuration shall be per manufacturer's recommendations based on total unit casting static pressure (simulated plugged filter condition), but not less than 3 inch water seal.
 - 3. Running trap design is not permitted.
 - 4. Secondary drain shall not be trapped.
- D. Condensate trap shall be checked at equipment operational tests for proper water drainage flow from air conditioning unit. Cooling condensate pan shall be filled with water, filters covered with plastic (plugged filter simulated), unit panels replaced, and unit motor running at design condition. Pan shall drain without hesitation to bottom of inlet connection. Tests are made prior to installation of ceiling.
- E. Secondary Overflow Drain:
 - 1. Drain pan installed underneath air conditioning units in concealed ceiling space or units that incorporate dam fitting shall be furnished with secondary drain piped to outside planter area with outflow location clearly visible.
 - 2. If outside building location is not available or feasible, secondary drains shall be piped to a classroom sink, if sink is not available pipe to a room corner away from cabinets, computers, desks, door ways/entrances or stairs.
 - 3. Secondary vertical pipe that penetrates through suspended ceiling shall be furnished with a coupling or threaded adapter so ceiling tile can be removed without damage.

3.07 CONDENSATE DRAINS - FROM WINDOW TYPE HEAT PUMP AND EXTERIOR WALL MOUNT HEAT PUMP UNITS

- A. Whether indicated on Drawings or not, window units and wall mount units without built in bottom drain pan for evaporator and condenser coils shall be provided with galvanized steel condensate pan at bottom of unit with drain line that drains into

approved drywell. Install copper 1/2 inch diameter pipe for window type air conditioners and 3/4 inch diameter pipe for exterior wall-mounted heat pump units.

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3.08 MAKE-UP WATER SYSTEMS

- A. Provide and connect make-up water systems for equipment in other sections.

3.09 GREASE TRAPS (INTERCEPTORS)

- A. Grease traps shall be installed only when required by municipal authority. Grease traps shall be separately vented; fixtures connected to grease traps shall be trapped and vented. When grease traps are installed in concrete boxes, fill spaces between grease traps and concrete boxes with sand and place 2 inches of concrete seal over sand. Concrete seals shall pitch toward grease traps with inner edges flush with top of grease traps. Position openings for ease of cleanout.

3.10 GAS SERVICE

- A. Above Grade Service: Pipe shall be steel, hammered, free of dirt and scale, and blown out with oil-free air or nitrogen to a clean, dry condition. Piping shall not be installed in or through a ventilation duct or plenum.
- B. Underground Service, Gas approved (yellow) Polyethylene Plastic Pipe: Refer to Section 22 0513: "Basic Plumbing Materials and Methods".
1. Pipes shall be joined with polyethylene fitting and joined together by thermal fusion in accordance with procedures recommended by Polyethylene plastic pipe and fitting manufacturer.
 2. Plastic pipe shall be installed not less than 30 inches below grade.
 3. Underground Warning Tape shall be installed 12 inches above buried gas piping. Warning tape shall be yellow with caution statement as follows: "CAUTION – BURIED GAS LINE BELOW".
 4. Plastic pipe shall not be installed in or under a building or structure. Pipe shall be installed under bituminous surfacing or compacted soil area, free from large stones. Pipe may be installed under sidewalks or driveways, as long as no joint occurs. Pipe installed under paved covered areas wider than 40 feet shall be installed in ventilated conduits extending 2 feet past paving.
 5. Pipe shall be installed on a 6 inches deep sand bed. After required pressure-leak test, pipe shall be covered with sand not less than 6 inches thick.
 6. Piping shall not support weight of valves, metal fittings or other items. Pipe shall be installed strain free.
 7. Plastic pipe fittings shall not be stored or left exposed to sunlight. Pipe in open trenches shall be shielded. A sand envelope of 6 inches minimum shall be placed around pipe, with exception of joints, until inspection by IOR is

completed. Protection for pipe shall be provided when necessary to leave pipe exposed overnight.

8. Installer of piping is required to have training and to have attained a certification. Non-trained/Non-certified installer must contact the manufacturer or manufacturer's representative to provide on-site fusion training and certification, prior to work commencement
9. Polyethylene plastic pipe shall connect to a steel epoxy coated anodeless type riser to minimum of 6 inches above grade, when exiting the underground installation and transitioning to steel pipe connection.
10. Where a steel pipe riser passes into a structure or building, a double swing or double-offset joint shall be furnished. Pipe shall pass into structure 6-inches above grade and through a sleeve with a minimum one inch clearance. An isolation valve is required before pipe entering the building.

3.11 CLEANING - PLUMBING PIPING SYSTEMS AND FIXTURES

- A. Plumbing lines and fixtures shall be flushed to remove dirt and foreign material until water runs clear and no foreign substance or odor is present. Strainers and screens on faucets shall be removed during this cleaning operation.
- B. After satisfactory cleaning of strainer and screen replacements has been witnessed by the Project Inspector, post and maintain signs stating: "CAUTION - Water at this construction project has not yet been certified for human consumption." Signs shall be furnished with letters at least 1/2 inch in height and shall be conspicuously posted at entrances to the Project site. Signs shall be paneled, black and yellow, in conformance with OSHA Section 1910.1455.

3.12 DISINFECTING DOMESTIC WATER PIPING SYSTEMS

- A. Newly installed or replaced piping and/or fixtures dispensing potable water, and any additional piping and/or equipment impacting the integrity of this system shall be disinfected and undergo an approved bacteriological analysis before water system is allowed for public use.
- B. Disinfection shall commence upon complete installation of all related domestic water systems including fixtures, valves, faucets, water heating systems, etc.
- C. Work shall be performed by Technicians Certified by the American Water Works Association (AWWA) and/or the State of California Department Health Services, Grade II Water Treatment Operator Certification or higher issued by the Department of Health Services (DHS) for the State of California. Comply with Title 22, Code of Regulations Division 4, Chapter 13, and Article 2 Operator Certification Grades.
- D. Method:

1. A Physical Separation of minimum 6" or Reduced Pressure Backflow assembly shall be installed to protect from cross contamination of the local water purveyor's meter service supply when at any time there is any type of water connection with the piping to be disinfected (Chlorinated) and the water meter service supply.
 2. Install a Chlorination Port including a T fitting and a shut off valve to the proximity of the point of connection at the new piping system.
 3. System is to be flushed to remove any materials that may have entered the system.
 4. Using a chemical feed metering pump and a chlorine tank, the chlorine solution is injected into the water system.
- E. Disinfection and De-chlorination procedure (24 or 3 Hour Contact Time):
1. 24-hour Test Method:
 - a. Prior to disinfection, post signs on all water outlets of the system to be disinfected. Sign or tags shall read, "Water System Being Chlorinated- "Danger Do Not Drink Water" or similar warning.
 - b. Piping system shall then be adequately flushed with water to remove any particles and eliminate air pockets.
 - c. Using the continuous feed method, sodium hypochlorite conforming to ANSI/ AWWA B300 will be injected into the water system at a minimum of 50 PPM. A water flow meter provided by the water treatment technician will be used to determine the rate of injection and a chlorine test kit, Hach or equivalent, will be used to monitor the residual.
 - d. Chlorine residual test will be taken at all appropriate points and outlets to verify 50 PPM residual levels.
 - e. The chlorinated system shall be shut down for any use and the chlorinated water shall remain in the water system for retention of 24 hours.
 - f. After 24 hours, chlorine residual levels will again be tested at various points throughout the system to insure a minimum of 25 PPM residual. If the system has not met the minimum of a 25 PPM residual, the above disinfection process shall be repeated.
 - g. After satisfactory completion of the residual testing, flush out system until Hach or equivalent test reveal the water outlets have a free chlorine residual concentration less than 0.5 PPM. The procedure shall be in accordance with the AWWA standard C651-05.

- h. The OAR may allow temporary use of the water system for construction purposes pending results of the bacteriological test analysis. Sign or Tags shall be left on all outlets stating water system is not safe for consumption until laboratory results are complete and meet these specifications.

2. 3 Hour Test Method:

- a. If the water systems must be turned on for use as soon as possible, a 3 hours chlorine contact time to allow for disinfection is permitted with the OAR's approval.
- b. Prior to disinfection, post signs on all water outlets of the system to be disinfected. Sign or tags shall read, "Water System Being Chlorinated- "Danger Do Not Drink Water" or similar warning.
- c. Piping system shall be then adequately flushed with water to remove any particles and eliminate air pockets. Using the continuous feed method, sodium hypochlorite conforming to ANSI/ AWWA B300 will be injected into the water system at a minimum of 200 PPM. A water flow meter provided by the water treatment technician will be used to determine the rate of injection and a chlorine test kit, Hach or equivalent, will be used to monitor the residual.
- d. Chlorine residual test will be taken at all appropriate points and outlets to verify 200 PPM levels. The chlorinated system shall be shut down for any use and the chlorinated water shall remain in the water system for retention of 3 hours.
- e. After satisfactory completion of a 3 hour disinfection period, flush out system until Hach or equivalent test reveal the water outlets have a free chlorine residual concentration less than 0.5 PPM. The procedure shall be in accordance with the AWWA standard C651-05.
- f. The OAR may allow temporary use of the water system for construction purposes pending results of the bacteriological test analysis. Sign or Tags shall be left on all outlets stating water system is not safe for consumption until laboratory results are complete and meet these specifications.

F. Bacteriological Test:

- 1. After final flushing and satisfactory results from the residual free chlorine concentration test, Bacteriological test samples shall be collected. The intent of the following is to provide insurance for an accurate representation to a complete Bacteriological test of the water system. At least two samples shall be taken from each floor of each building.
- 2. Bacteriological test samples shall be delivered to a State of California Department of Health Services Certified Laboratory to perform qualitative and

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quantitative bacterial analyses on the water samples for the presence of any Total Coliform bacteria and Plate Count. This count must be less than 500 cfu/mL.

3. The procedure shall be repeated if it shown by bacteriological examination made by an approved agency that the level of Disinfection does not meet these specifications.
 4. After satisfactory results for the bacteriological test are provided to the OAR, the physical barrier or temporary reduce pressure back flow devise shall be removed, and the new piping shall be connected to the point of connection. All the connecting piping and fittings shall be disinfected prior to installation. Chlorination Port shall be capped water tight. Warning sign or tags shall be removed.
- G. Drinking Fountain and Bottle Filler Lead Test: After installation of Drinking Fountain or Bottle Filler, and successful Bacteriological Test, shut off domestic water supply line feeding the fixture, and inform OAR. OAR will coordinate with the Drinking Water Quality Program (DWQP) Supervisor in local Project Unit and M&O's Plumbing Technical Unit Supervisor to conduct lead detection test and mitigate as necessary. Do not remove related construction warning sign and tags.

3.13 VALVES ON PLUMBING SYSTEM

- A. Furnish and install gates, ball, globes, angles, and check valves on plumbing Work at following locations whether indicated on drawings or not.
- B. Hot and cold valves shall be:
 1. Lead free complying with AB1953.
 2. Above the ground copper water system, 2-inch and larger, may utilize Victaulic butterfly valves and fittings for their connections. A 2-inch or larger Victaulic valve may be in a wall if an adequately sized access panel is provided for maintenance or removal.
- C. Valves shall be accessible and installed within an access panel approximately 3 feet above floor and no more than 7 feet above floor, or in a marked yard box to prevent tampering.
 1. Immediately after each water meter, in addition to any valve furnished by utility company, there shall be an accessible valve on the inlet side for a strainer assembly, dual backflow device assembly and/or possibly a dual pressure reducing valve assembly.
 2. A gate or ball valve on each water supply before it enters building. Valves shall be accessible from outside building and shall be installed in a marked yard box, unless otherwise indicated on drawings. Ball valves 2 ½-inch size or larger shall omit gate valve handle and furnish 2-inch square operating nut.

3. At multi story buildings, provide an isolation-valve or multiple valves for both hot and cold water in access panel to isolate and control each floor level.
4. For classrooms, shops, offices and boiler or mechanical room, install a gate or ball valve to control hot and cold water lines to each group of fixtures, a group of fixtures shall be considered to be 2 or more fixtures in the same room. When practical, valves shall be installed on the same wall as group of fixtures. Valves shall control only fixtures in rooms in which they are installed.
5. For restrooms, a gate or ball valve shall be installed in each restroom to isolate the hot and cold water supply into a restroom regardless of the number of fixtures. These valves shall control and be accessible only from within the restroom in which fixtures are installed. Valves shall be installed on the same wall as the group of fixtures it serves. Valves shall control only fixtures in restroom in which they are installed. Back to back restrooms shall be isolated separately and individually.
6. Install a gate or ball valve on each building branch line, which serves two or more fixtures, when these fixtures are not provided with a group isolation valve as specified above. These valves shall be located approximately 3 feet but not more than 7 feet above finish floor.
7. Install a gate, ball valve or partition stop for a drinking fountain or a group of drinking fountains.
8. Install a gate, ball valve or partition stop for hot and cold water supply to plumbing fixtures with no accessible supply stops, such as wall mounted faucets.
9. Install a gate, ball valve or partition stop for stops adjacent to, and controlling water flow to each sill cock and hose bib except as follows:
 - a. A sill cock immediately below an exterior drinking fountain may be controlled by the same gate, ball valve or partition stop as drinking fountain.
 - b. Valves or stops will not be required for individual hose bibs when these hose bibs are on a branch line serving only hose bibs and branch line is furnished with a shut-off valve.
10. Install a lose key angle stop, on each exposed fixture supply, and for each flush valve unless otherwise specified,
11. Install gate or ball valve at each location where a water line is connected to a piece of equipment other than items mentioned above.
12. Install a check valve on each hot water return line where it connects to a hot water storage tank or a water heater.
13. Handles, hand wheels (including dishwasher fill valve handles) and operating nuts shall be furnished of steel, brass, or cast iron and shall be removable.

Unless specified to be loose key type, handles shall be securely fastened to their stems. On exposed outdoor valves, omit operating handles and provide operating nuts.

14. Provide a handle or a key for each five, or fraction thereof, loose key valves, bibs, or stops and deliver them to the project OAR.

3.14 VALVES - GAS SERVICE

- A. A gas readily accessible shut-off stop shall be installed on each gas line entering a building immediately prior to the point it enters the building. Unless otherwise specified or indicated, shut-off valves for lines entering a permanent structure, buildings or portable buildings, shall be installed in a vertical riser above grade.
 1. Gas shut off valve for portable buildings – In addition to the gas readily accessible shut-off stop specified above, a dedicated Gas shut off valve shall be provided in a marked Yard Box, for each portable building to facilitate relocation/removal of building without the need to shut off gas to entire school.
- B. Gas Shut off valve within a building – A gas shut off valve with handles shall be accessible and serviceable within an access panel. Install valve minimum 3 feet above floor but less than 7 feet above floor.
- C. In addition to locations specified, gas shut off valve shall be installed at following locations:
 1. Install a lubricated plug gas shut off valve on any line connected to gas main or header at master assembly.
 2. Install a lubricated plug gas shut off valve before entering any building or structure.
 3. Install a gas valve on each outlet, in addition to any gas stop furnished with equipment.
 4. Service to laboratory gas cocks shall be furnished with a special precision check valve, located downstream from gas stop servicing room outlet at each laboratory cock. Unless otherwise specified, 1/8-inches bore shall be provided for each outlet cock.
 5. Install a gas shut-off valve on each gas line serving 2 or more gas outlets in same room. Service stop shall be installed not more than 7 feet above floor, and shall be in the room it serves.
 6. Install a gas shut-off valve on inlet side of each gas pressure regulating valve.
 7. Gas shut-off valves to be furnished with equipment.

8. Install gas shut-off valve at not more than 1,000 foot intervals on each gas main.
 9. At multi-story buildings, provide gas-shut off valve(s) to isolate and control each floor or level. Install valves in a concealed manner in walls with access panels.
 10. Gas shut-off valves in classrooms and locations subject to tampering shall be protected while remaining accessible.
- D. When a gas-shut off valve adjacent to gas-fired equipment is indicated in Contract Documents it shall be furnished and installed as part of Work of this section.
- E. When electrical wall switches with emergency push button are specified for controlling gas outlets at Laboratory Classrooms, provide main shut-off gas valve with normally closed electric solenoid valve within an accessible access panel.

3.15 ELECTROLYSIS PREVENTION

- A. Brass nipples, 6 inches, with recognized brass unions; flanges shall be furnished and installed at locations described herein. Flanges shall be installed with complete insulating component consisting of gasket bolt sleeves and bolt washers. Dielectric insulators shall be installed at following locations:
1. Where special applications indicated on Drawings require an insulation flange or brass union, with 6-inch brass nipple to be installed in a condensate line, or steam line, flange insulation shall be of a high temperature type, suitable for continuous operation at temperatures up to 220 degrees F. for condensate and 400 degrees F. for steam.
 2. Where steel or cast iron in ground connects to copper or brass piping above ground, transition from steel or cast iron pipe to copper or brass pipe shall be provided in an accessible location.
 3. Underground dielectric connections shall be furnished in accessible yard boxes.
 4. Above ground dielectric connections shall be exposed; or if in finished rooms shall be located in accessible access boxes.

3.16 UNDERGROUND PIPE MARKERS

- A. Pipe markers shall be furnished according to Section 22 0553: "Plumbing Identification"
- B. Underground Caution Tape shall be placed 12 to 18 inches above the utility line. The Caution Tape shall be a designated color and marked with the appropriate name for the specific type of utility pipe as follows:
1. Yellow – with the words: CAUTION GAS LINE BELOW

2. Blue – with the words: CAUTION WATER LINE BELOW

3.17 HOT WATER CIRCULATING PUMPS

- A. Floor-mounted pumps shall be provided with a 4-inch high concrete base with ½ inch reinforcing bars at 12-inch centers each way and doweled into concrete floor.
- B. Piping shall be supported from building structure so as to prevent any strain on pump casing.
- C. In-line pumps, unless otherwise specified, shall be centrifugal type with non-overloading characteristics and shall not overload motor above its horsepower rating under operating conditions with ratings based on continuous operation.
- D. Centrifugal water pumps shall be rated according to Hydraulic Institute Test Code for Centrifugal Pumps. Pumps shall be furnished with bronze water chamber, bronze impeller and mechanical seal. Rotating parts shall be statically and dynamically balanced.
- E. Flanged connections shall be provided on pumps with discharge connections larger than 2 inches. Smaller sizes may be threaded connections.
- F. Hot water circulating pump shall be arranged so that pump can be automatically turned off when hot water system is not in operation.

3.18 WATER TEMPERATURE CONTROLLERS

- A. Furnish and install a water temperature controller in hot water line adjacent to, and for control of, circulating pumps on hot water return lines when said pump is indicated on Drawings or herein specified. Bulb of temperature controller shall be installed so as to be directly in path of flowing water and so as not to obstruct flow of water.
- B. Furnish and install a water temperature controller in hot water storage tanks for control of circulating pump on hot water circulating line when said pump is indicated on Drawings or specified herein.

3.19 COMPRESSED AIR SYSTEMS

- A. Compressed air systems including compressors, air line filters, receivers, piping and appurtenances shall be installed as indicated and specified.
- B. Component parts of compressor unit shall be installed on a base firmly attached to receiver; motor and compressor shall be properly aligned auxiliary equipment and controls specified, furnished with necessary controls, automatic moisture eliminator fittings, piping, conduits and wiring properly installed and connected in a professional manner. Lubricant shall be furnished to fill until ready for operation. Safety valves shall be installed to permit normal operation and properly protect equipment. Thermal units shall be installed in motor starter to trip at 125 percent of motor nameplate rating. Pressure switches shall be installed to cut in and cut out of settings indicated.

- C. Compressor shall be installed on vibration dampers and flexible connections installed in piping to isolate vibration. Dampers shall be furnished with transmissibility of less than 10 percent for grade installation and less than 5 percent for above grade floor installation.
- D. Furnished compressed air system shall comply with safety orders of Industrial Accident Commission of State of California, Building and Safety Department of City of Los Angeles, and electrical units shall be listed as UL approved. Piping between first downstream moisture eliminator and receiver shall pitch down to receiver and shall be not less than one pipe size larger than pipe leaving eliminator. Provide drip points at each building with piping pitching down to them. Drip leg at each drip point and moisture eliminator shall be not less than 6 inches long, capped 1 ½-inch pipe with drain petcock. Upon completion of compressed air piping installation and prior to testing of pipe and final connection to compressed air receivers, systems shall be blown out to a clean, dry condition.

3.20 DEPTH OF SEWER LINES

- A. Minimum depth of below grade sewer lines shall be 24 inches to centerline of pipe. Sewer lines shall slope ¼ inch per foot minimum, unless otherwise indicated. Minimum depth at Owner property line shall be 6 feet, unless otherwise required.

3.21 BACKFLOW PREVENTION DEVICES

- A. Backflow Devices: Installation of backflow devices shall be tested and certified by Los Angeles County backflow device tester before Substantial Completion. Tests shall be performed in presence of Project Inspector. Test reports shall be turned over to Project Inspector for mailing to proper agency.

3.22 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose off Project site.

3.23 PROTECTION

- A. Protect Work of this section until Substantial Completion.

END OF SECTION

**SECTION 23 0500
COMMON WORK RESULTS FOR HVAC**

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. This Section provides the basic mechanical requirements that apply to the Work of Division 23.
- B. Related Requirements:
 - 1. Division 01: General Requirements.
 - 2. Division 26: Electrical.

1.02 REGULATORY REQUIREMENTS

- A. Materials, fabrication, equipment, and installation shall comply with industry standards and code requirements. Where manufacturer's recommendations exceed industry standards, the manufacturer's recommendation shall establish the minimum standard. As a minimum, standards from the following organizations shall apply:
 - 1. AMCA - Air Movement and Control Association.
 - 2. ANSI - American National Standards Institute.
 - 3. ASME - American Society of Mechanical Engineers.
 - a. ASME Boiler and Pressure Vessel Code.
 - b. ASME B31 - Code for Pressure Piping.
 - 4. AHRI - Air-Conditioning, Heating, and Refrigeration Institute.
 - 5. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers.
 - 6. ASTM - American Society for Testing and Materials.
 - a. ASTM A53 - Specification for Welded and Seamless Pipe.
 - 7. CSA - Canadian Standards Association.
 - 8. FM Global - Factory Mutual Global
 - 9. IAPMO - International Association of Plumbing and Mechanical Officials.
 - 10. NFPA - National Fire Protection Association.
 - 11. OSHA - Occupational Safety and Health Administration.
 - 12. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
 - 13. UL - Underwriters Laboratories Inc.
 - 14. Intertek (ETL Certification).

- B. Materials, fabrication, equipment, and installation shall comply with federal, state, and local codes including, but not limited to, the following:
 - 1. CBC, California Building Code, and CMC, California Mechanical Code.
 - a. Latest edition as adopted by the City of Los Angeles, the County of Los Angeles, and the State of California including amendments effective on the Effective Date of the Contract.
 - 2. California Code of Regulations, Title 8, Industrial Relations, Division 1, Chapter 4, Division of Industrial Safety.
 - 3. OSHA - Occupational Safety and Health Administration.
 - 4. CDPH – California Department of Public Health.
 - 5. SCAQMD - South Coast Air Quality Management District.
- C. Specifications or Drawings shall not be construed to permit deviation from the requirements of governing codes unless approval has been obtained from legally constituted authorities having jurisdiction, and the Architect. The Contract Documents may contain more stringent requirements than those legally required.
- D. Permits and Fees: Refer to the General and Supplementary Conditions.

1.03 SUBMITTALS

- A. Provide submittals in accordance with Section 01 3300: Submittal Procedures and with specific requirements of Division 23 sections, as applicable.
- B. After Architect's approval, the above information shall become the basis for inspecting and testing materials and actual installation procedures performed in the Work.
- C. Shop Drawings: Submit one additional copy when control diagrams having line voltage connections are indicated. Shop Drawings shall be specifically prepared for the Work of this Project. Drawings prepared in accordance with requirements of Section 01 3113: Project Coordination and Section 01 3300 may be provided by the Architect to serve as a background for the Shop Drawings. Shop Drawings shall comply with the requirements of Section 01 3113 and Section 01 3300 and shall indicate at a minimum:
 - 1. Complete system layout of equipment, components, ductwork, and piping, indicating service clearances, duct and pipe sizes, fitting types and sizes, top or bottom of duct and pipe elevations, distances of ducts, pipes and equipment from building reference points and hanger / support locations. All the above items shall be coordinated on the shop drawings according to the requirements of Section 01 3113.
 - 2. Schedule and description of equipment, ductwork, piping, fittings, valves, dampers, and controllers.

1.04 PROJECT RECORD DOCUMENTS

- A. Comply with provisions of Section 01 7700: Contract Closeout.
- B. Project Record Drawings:

1. Provide a complete set of mechanical and control system drawings in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks and plotter pen color/line thickness settings on CD-ROM. Also submit one set of full size reproducible plots on vellum and three sets of prints.
 2. Before Contract Completion, deliver corrected and completed prints to the OAR. Delivery of project record documents to the OAR does not relinquish responsibility of furnishing required information omitted from project record documents.
- C. Operation and Maintenance Manuals:
1. Submit operation and maintenance manuals in required form and content. If no revisions are required, furnish one additional copy. If revisions are required, one copy shall be returned with instructions for changes; perform such changes and return manuals. Manuals shall be bound in accordance to Section 01 7700. Deliver manuals to the OAR. Submit an electronic copy of the entire manual in PDF file format.
 2. Contents of Manual:
 - a. Title sheet with Project name, including names, addresses and telephone number of Contractor, installer, and related equipment suppliers.
 - b. Manufacturer's operating instructions including, but not limited to, the following:
 - 1) Identification of components and controls.
 - 2) Pre-start checklist and start-up procedures.
 - 3) Normal operation settings and checklists.
 - 4) Pre-shut down checklist and shut down procedures.
 - 5) Trouble shooting checklist and guidelines.
 - 6) Recommendations for optimum performance.
 - 7) Warnings and safety precautions on improper or hazardous operational procedures or conditions
 - c. Manufacturer's product data and parts and maintenance booklet for each item of equipment furnished under Division 23 that includes the following as a minimum:
 - 1) Manufacturer's model, identification and serial numbers.
 - 2) Exploded view of assembly drawings identifying each component or part with the relevant part number.
 - 3) Directory of manufacturer's representatives, service contractors and part distributors.
 - 4) Maintenance and trouble-shooting instructions, including schedule for preventive maintenance, periodic inspection and cleaning criteria.

- d. Project Record Drawings: Complete set of mechanical and control system drawings in 50 percent reduced print format shall be furnished with the manual. Submit the above record drawings on CD-ROM in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks, and plotter pen color/line thickness settings.
- e. Testing, Adjusting, and Balancing reports: Submit as specified in Section 01 4525.
- f. South Coast Air Quality Management District (SCAQMD) permits to install and operate boilers, water heaters and other fuel burning equipment and third-party source test reports as required by SCAQMD to allow start-up and operation of equipment.
- g. Los Angeles County industrial waste permits.
- h. Valve directory complete with location, function, size, and model of each valve with reference to the project record drawings.
- i. Equipment and component identification chart complete with location, function, size, and model of each equipment or component with reference to the project record drawings.

1.05 COORDINATION

- A. Contract Documents indicate extent and general arrangement of Work under Division 23. Contractor shall coordinate work in accordance with Section 01 3113 requirements and make adjustments as required to provide maximum headroom, a neat arrangement to keep passageways and openings clear to provide accessibility and provisions for maintenance, and to meet code requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Storage: Deliver materials to Project site in their original unopened containers with labels intact and legible at time of delivery. Store in strict accordance with manufacturer's recommendations.
- B. Do not store plastic pipe or materials in direct sunlight.

1.07 PRELIMINARY OPERATION

- A. OAR may require any portion of mechanical Work to be operated before Substantial Completion. Such operation shall be in addition to regular tests, demonstrations and instructions required under the Contract Documents, and shall be performed as required.
- B. Notify the Project Inspector at least 24 hours in advance of lighting or re-lighting pilots.

1.08 TRAINING OF OWNER PERSONNEL

- A. Training of Owner's personnel shall include:
 - 1. A minimum of 8 hours of on-site overview of the overall Mechanical System.

2. Refer to Division 23 sections for specific training on each of the components of the Mechanical System.
 3. A minimum of 8 hours of on-site overview identifying location and function of all Control Valves and Actuator assemblies.
 4. A minimum of 40 hours of (in classroom) software training for a minimum of 20 LAUSD personnel on EMS/BMS if such systems are utilized in the project. Training shall be conducted at control contractor training facility with computer setup for each person attending.
- B. Contract shall include the cost of training Owner operation and maintenance personnel in operating, adjusting, maintenance, trouble-shooting, and Project site repair of each component, equipment, or system provided under this Contract.
 - C. Operational and maintenance training shall be conducted on the Project site, unless indicated otherwise.
 - D. Upon completion of Owner training, a completion certificate indicating the nature of the training and a description of the systems, complete with equipment and component lists shall be issued to each trainee. The certificate should be issued in duplicate with one copy retained by OAR.
 - E. An attendance sheet with the names and signatures of all participants attending the training shall be submitted to the OAR and kept as part of the project documents.
- 1.09 GUARANTEES AND DAMAGE RESPONSIBILITY
- A. Sound of water flowing in piping shall not be transmitted to building structure. Operation of mechanical system shall not produce operational sounds that can be heard outside of rooms enclosing apparatus or equipment.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Unless otherwise specified, materials and equipment shall be new, in good and clean condition. Equipment, materials, and components shall be of the make; type and model number noted on Drawings or specified. Pieces of equipment of the same type shall be by the same manufacturer.
- B. Whenever an item is listed by a single proprietary name, with or without model number and type, it shall be for purpose of design only, to indicate characteristics and quality desired. Proprietary designation listed on Drawings, or listed first in Specifications, is used as a basis for design to establish a standard for quality and performance and space requirements.
- C. HVAC equipment products from different manufacturers are never identical. Equipment approved as being equal is interpreted as being equivalent in capacity, performance and quality. The dimensions, weight, configuration and utility requirements could be quite different from the equipment used as the basis of design. Due to these differences, additional coordination and adjustments by the Contractor are required. For the equipment to be deemed

truly equal, the additional coordination and adjustments by the Contractor should not incur any additional cost to the Owner and any additional labor to the design team.

- D. Equipment and materials indicated or required to be installed outdoors shall be of the type that is designed, manufactured, listed or approved by authorities having jurisdiction for outdoor installation by being resistant to the adverse effects of weather. All the additional protective measures against outdoor weather required by the manufacturers' installation instructions and prevalent practice shall be provided.
- E. For substitution of materials or products, refer to the General Conditions.

PART 3 – EXECUTION

3.01 SERVICE INTERRUPTIONS, OFF-SITE, GAS AND WATER

- A. Schedule Work so there shall be no service interruptions of existing systems or systems during normal hours of operation of affected systems and facilities.
- B. When service interruptions are mandatory, arrange in advance with the OAR as to time and date of such interruptions.
- C. Systems, which are interrupted, shall be returned back into operation in such manner that they will function as originally intended.

3.02 CUTTING, NOTCHING, AND BACKING

- A. Conform to California Building Code, Title 24, Part 2, for notches and bored holes in wood and for pipes and sleeves embedded in concrete and for cuts in steel, as detailed on structural Drawings.
- B. Where pipes or ducts pass through, or are located within one inch of any construction element, install a resilient pad, 1/2 inch thick minimum, to prevent contact.
- C. Furnish all necessary provisions for recesses, chases, and accesses and provide blocking and backing as necessary for proper reception and installation of mechanical Work.

3.03 LOCATION OF PIPING AND EQUIPMENT

- A. Location of piping, apparatus and equipment as indicated on Drawings is approximate and shall be altered to avoid obstructions, preserve headroom, and provide free and clear openings and passageways.
- B. Trenches parallel to footings shall not be closer than 18 inches to the face of footings and shall not be below a plane having a downward slope of 2 horizontal to one vertical, from a line 9 inches above bottom of footing.
- C. Pipe in tunnels shall be installed close to one side of tunnel to provide maximum space for passage. Pipe shall not be installed through crawl hole unless otherwise specified or detailed on Drawings.
- D. Place equipment in locations and spaces indicated, disassemble and/or reassemble equipment as required by Project conditions.

3.04 TESTS AND TESTING

- A. Tests shall be as required under the applicable sections of Division 23, including this Section.
- B. Tests required by other sections of the Contract Documents include the following:
 - 1. Test and balance of mechanical equipment and systems: Refer to Section 01 4525: Testing, Adjusting, and Balancing for HVAC.
 - 2. Hydrostatic test of boilers: Refer to Section 01 4525: Testing, Adjusting, and Balancing.
 - 3. Test of smoke and fire detectors: Refer to Division 26: Electrical.
- C. Additional tests may be required in the case of products, materials, and equipment if:
 - 1. Submitted items are altered, changed, or cannot be determined as exactly conforming to the Contract Documents.
 - 2. Performance testing and results may also be required on certain items which are as specified, including fan, and pump performance.
- D. Piping Tests:
 - 1. Perform tests required to demonstrate that operation of mechanical systems and their parts are in accordance with Specifications covering each item or system, and furnish materials, instruments and equipment necessary to conduct such tests. Tests shall be performed in presence of the Project Inspector, and representatives of any governmental agency having jurisdiction. Work shall not be concealed or covered until required results are provided.
 - 2. If required tests are not performed, Owner may provide in accordance with the Contract Documents.
 - 3. Pressure gages furnished in testing shall comply with CPC. Air shall be bled from lines requiring hydrostatic or water tests.
 - 4. Systems shall be pressure-tested in accordance with pipe testing schedule below. Pipe test shall indicate no loss in pressure after a minimum duration of 4 hours at test pressures indicated. Where local codes require higher test pressures than specified herein for fire sprinkler systems, local codes shall govern.
 - 5. Fuel gas lines shall be first tested with piping exposed, before backfilling trenches or lathing; second with piping in finished arrangement, backfilled and paved where required, and walls finished.
 - 6. Refrigerant piping may be tested with a halide detector or calibrated electronic testing equipment.
 - 7. Piping systems may be tested as a unit or in sections, but entire system shall successfully meet requirements specified herein, before final testing by the Project Inspector.

8. Repair of damage to pipes and their appurtenances or to any other structures resulting from or caused by these tests, shall be provided.

E. Pipe Testing Schedule:

System Tested	Test Pressure (psig)	Test With:
Steam piping, hot water heating system piping and chilled water piping	150	Water
Vacuum pump or condensate pump discharge and condensate return piping	150	Water
Refrigeration piping		
R-22	400	Dry nitrogen
R-134a	300	Dry nitrogen
R-401a	300	Dry nitrogen
R-401b	300	Dry nitrogen
R-404a	500	Dry nitrogen
R-407c	500	Dry nitrogen
R-410a	600	Dry nitrogen
R-507	500	Dry nitrogen
Radiant panel piping	150	Water

F. Equipment Performance Assurance Tests:

1. Before operating any equipment or systems, a thorough check shall be performed to determine that systems have been flushed and cleaned as required and that equipment has been properly installed, aligned, lubricated, and serviced. Factory instructions shall be checked to verify installations have been completed and recommended lubricants have been installed in bearings, gearboxes, crankcases, and similar equipment. Particular care shall be furnished in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Equipment shall also be checked for damage that may have occurred during shipment, after delivery, or during installation. Damaged equipment, products, and materials shall be replaced or repaired as required.
2. Upon completion of the above, adjust the system settings to within normal operating conditions to prevent the system from being damaged upon start-up.
3. Run-test the equipment after start-up for five consecutive days. Tests shall include operation of heating, ventilating, and air conditioning equipment and systems for a period of not less than two 8 hour periods at 90 percent of the full specified heating and cooling capacities. If equipment passes, install new filters. If equipment fails, it shall be adjusted and retested until system meets all applicable codes.
4. Equipment Start-up Reports: For each equipment or system on which start-up is performed, submit 8 copies of start-up report for review by the Architect.

- a. The start-up report shall include the manufacturer's standard start-up form completed and signed by the start-up technician.
 5. Provide, maintain, and pay costs for equipment, instruments, and operating personnel as required for specified tests.
 6. Provide electric energy and fuel required for tests.
 7. Final adjustment to equipment or systems shall meet specified performance requirements.
 8. Equipment, systems, or Work deemed defective during testing shall be replaced or corrected as required. Test until satisfactory results are provided.
- G. Specific Coordinated Plan for Test and Balance:
1. Provide a narrative of the operational intent that clearly describes the function and sequence of operation of each component, equipment, or system installed. Instruct designated Owner personnel in the operation of the installed systems.
 2. Prior to final test and balance, mechanical equipment and systems shall be operated and tested as indicated in Paragraph 3.04.F above to demonstrate satisfactory overall operation of the installed systems.
 3. Immediately before starting tests, air filter media shall be cleaned or renewed. Roll-type filters shall be advanced to provide new clean media. Cleanable type media shall be thoroughly cleaned and re-oiled with new, clean oil as

recommended by manufacturer if they are of viscous impingement type. Disposable type filters shall be replaced with new filters. Replaceable media shall be replaced with new media.
 4. An accurate means of measuring air flow and temperatures shall be furnished to balance air supply, return, and exhaust systems so uniform temperatures occur in every room and design airflow is obtained through registers, diffusers, and grilles.
 5. Systems shall be adjusted to provide airflows indicated including maximum fresh air and maximum return air. Dampers shall be checked for proper settings and operation. Air and water inlet and leaving temperatures at coils shall be checked. Complete operational data including airflows, room temperatures, fan speeds, motor currents, plenum, and duct static pressures shall be tabulated.
 6. Welding performed as part of this Division may be subject to radiographic inspections at random in accordance with requirements specified in Section 23 0513: Basic HVAC Materials and Methods.

3.05 NOISE AND VIBRATION REDUCTION

- A. Correct noise or vibration caused by mechanical systems. Provide all necessary adjustments to specified and installed equipment and accessories to reduce noise to the lowest possible level

- B. Correct noise or vibration problems caused by failure to install work in accordance with Contract Documents. Include all labor and materials required as a result of such failure. Pay for re-testing of corrected noise or vibration problems by the project acoustical consultant including travel, lodging, test equipment expenses, etc.

3.06 PROTECTION, CARE AND CLEANING

- A. In addition to storage criteria of the General Conditions, and provisions under Section 01 5000: Construction Facilities and Temporary Controls, the following shall be provided:
 - 1. Provide for the safety and good condition of materials and equipment until Substantial Completion. Protect materials and equipment from damage.
 - 2. Protect installed Work.
 - 3. Replacements: In case of damage, immediately provide repairs and/or replacements as required.
 - 4. Protect covering for bearings, open connections to tanks, pipe coils, pumps, compressors and similar equipment.
 - 5. Interior of ductwork shall be maintained free of dirt, grit, dust, loose insulation, and other foreign materials.
 - 6. Air handling equipment shall not be operated until building is cleaned and air filters are installed.
 - 7. Fixtures, piping, finished brass or bronze, and equipment shall have grease, adhesive, labels, and foreign materials removed. Chromium, nickel plate, polished bronze or brass Work shall be polished. Glass shall be cleaned inside and out.
 - 8. Before initial start-up and again before Substantial Completion, piping shall be drained and flushed to completely remove grease and foreign matter. Pressure regulating assemblies, traps, strainers, boilers, flush valves, and similar items shall be thoroughly cleaned. Tag system with an information tag listing responsible party and date of element, before initial start-up and again before Substantial Completion. Compressed air, oil, and gas piping shall be blown out with oil-free compressed air or inert gas. Refrigerant piping shall be cleaned as specified.

END OF SECTION

SECTION 23 0513
BASIC HVAC MATERIALS AND METHODS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. This Section prescribes basic materials and methods generally common to the Work of Division 23.

B. Related Requirements:

1. Division 01: General Requirements.
2. Division 07: Thermal and Moisture Protection: Polyvinyl-Chloride Roofing.
3. Division 23: Heating, Ventilating, and Air-Conditioning.
4. Division 26: Electrical.
5. Section 31 2323: Excavation and Fill for Utilities.

1.02 SUBMITTALS

- A.** Provide in accordance with Division 01, Section 23 0500 and specific requirements of each section of Division 23.

1.03 QUALITY ASSURANCE

- A.** Standards: Comply with applicable national, state, and local codes and standards: ASTM, ASME, and ANSI. Federal Specifications, AWWA, CISPI, NFPA, FM Global, UL, CPC (California Plumbing Code), CMC (California Mechanical Code), CSA.
- B.** Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production as reviewed by the Architect.

1.04 COORDINATION

- A.** Coordinate related Work in accordance with provisions of Section 01 3113: Project Coordination.

PART 2 – PRODUCTS

2.01 GENERAL

- A.** Provide the following products if they are indicated in the Contract Documents or if they are required for the proper installation, function or operation of equipment, systems or components indicated in the Contract Document.

- B. Provide the following products as a complete assembly with required accessories for a complete and functioning entity in compliance with governing codes and applicable standards as specified in Section 23 0500, manufacturer's instructions or as required.

1. Omission of minor details in the Contract Documents does not waive and/or otherwise relinquish compliance with the above requirements.

2.02 MANUFACTURERS AND MATERIALS

- A. Air Compressor:

ACA-1 Electric motor-driven, air-cooled, duplex, air compressor, installed on a horizontal air storage tank, of the size and capacity indicated on the Drawings, with multiple V-belt drive, totally enclosed crankcase and required accessories such as pressure regulating stations, gravimetric moisture separators, on/off controls and safety controls for a complete pneumatic control air or laboratory instrument air station.

Quincy, DeVilbiss, FS-Curtis, Champion, Ingersoll Rand, or equal.

- B. Air and Dirt Separators:

AS-1 Furnish Spirotherm, Bell and Gossett, or Wessels air and dirt separation fitting on the hot water heating system, chilled water system, and closed loop fluid cooler system. Fittings shall be fabricated steel, rated for 150 psig design pressure and selected for less than one foot of water pressure drop and entering velocity not to exceed 4 feet per second at specified GPM. Performance curves from the unit manufacturer shall be furnished as part of the submittal for each unit. Units shall be furnished with internal copper coalescing medium to facilitate maximum air and dirt separation and suppress turbulence. Units shall be furnished with galvanized steel strainer and stainless steel collector tube. Provide integral high capacity float actuated air vent at top fitting of tank. Furnish cast iron float actuated air vent rated at 150 psig, threaded to the top of the fitting. Unit shall be furnished with the bottom of the vessel extended for dirt separation with the system connection nozzles equidistant from the top and bottom of the vessel and shall include a blowdown connection and valve.

Bell and Gossett, Spirotherm, Wessels, or equal.

- C. Balancing Valves:

BBV-1 Dual purpose, balancing and shut-off:

1. Direct operated Pressure Regulator: Class 200# SAG duct iron body, silicone chrome spring, stainless steel 316L Bellows/push rod.
2. Pilot operated Pressure Regulator Class 250# SAG cast iron body, cast iron cover, stainless steel valve stem, valve seat.
- Sarco Type BRV 2, 71, 25P Armstrong GD 45 GP 28
Hoffman series 754

- D. Boiler Blow-Off Valve:

BOV-1 Boiler blow-off (drain): Refer to Section 23 5000.

E. Ball Valves: Bronze, 2 inches and smaller:

BV-1 Class 150, 600 psi, CWP, 2 piece construction reinforced Teflon seats, full port, adjustable packing gland, stainless ball and stem, threaded ends.

Hammond UP-8303A/UP-8305/UP-8513, NIBCO T-685-80-LF/TS-685-66-LF, Milwaukee
UPBA400S/450S, or equal.

BV-2 Class 150, 600 psi CWP, 2-piece construction, bronze body, reinforced Teflon seats, adjustable packing gland, (no threaded stem designs allowed), threaded ends.

Hammond UP8301A, NIBCO T-585-70, Milwaukee BA-400, or equal.

Ball Valves in Insulated Piping: Use extended operating handle of non-thermal conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied. NIBCO Nib-Seal Handle.

F. Butterfly Valves:

BFV-1 Centerline Series A, 200 psi CWP tight shut-off.

1. Body: Lug type ductile iron. Suitable for bi-directional dead-end service at rated pressure without use of downstream flange.
2. Disc: Bronze, or aluminum bronze.
3. Stem: One or two-piece, 400 series stainless steel.
4. Seat and O-Rings: EPDM.
5. Upper and Lower Stem Bearings: Copper alloy or non-metallic material.
6. Operators: Valves 6 inches and smaller, with lever handle. Valves 8-inch and larger, with manual gear operator and disc position indicator.
7. Manufacturers:
 - a) Valves 2.5 to 6-inch: NIBCO, Milwaukee ML-233E, Hammond 6411-03, or equal.
 - b) Valves 8-inch and larger: Milwaukee ML 333E, Hammond 6411-03, NIBCO LD 2000, or equal.
8. Grooved ends: Valves 6 inches and smaller, Victaulic No. 700 or NIBCO No. GD-4765-3 with lever handles. Valves 8 inches and larger, Victaulic VIC-300 Masterseal Series 761, NIBCO No. GD-4765-5, Gruvlok Fig. 7700 Series, or equal, with manual gear operator and disc position indicator.

G. Check Valves:

1. Bronze, 2-inch and smaller:

CHV-1 Class 125, 200 CWP swing check, Teflon disc, threaded ends. .

NIBCO T-413-Y, Milwaukee 509-T, Hammond IB-940, or equal.

CHV-2 Class 150, 300 psi, CWP, swing check, bronze, Teflon disc, threaded ends:

Stockham B-321; Crane 11TF, NIBCO T-433, Milwaukee 510-T, Hammond IB-946, or equal.

2. Cast Iron 2-1/2 and larger:

CHV-3 Class 125, 200 psi, CWP, IBBM, renewable seat and disc, bolted cap, threaded ends:

Crane 372, Stockham G-927, NIBCO T-918-B, or equal.

CHV-4 Class 125, 200 psi, CWP, IBBM, renewable seat, bronze or cast iron disc, bolted cap, flanged ends:

Stockham G-931, Crane 373, NIBCO F-918 B, Milwaukee F-2974-M, Hammond IR-1124-HI, or equal.

CHV-5 Class 250, 500 psi, CWP, iron body, renewable bronze seat and disc, bolted cap, flanged ends:

Stockham F-947, Crane 39E, NIBCO F-968B, Milwaukee F-2970-M, Hammond IR-322, or equal.

CHV-6 On pump discharge, Class 250, 400 psi, CWP, wafer check, center guided disc, spring actuated:

NIBCO W-960B, Keckley Co. Style CW, Val-Matic 1400, or equal.

CHV-7 300 psi, ASTM A395 and A536 ductile iron body, stainless steel shaft and spring, grooved end:

Victaulic Series 716, or series 779 with Venturi-like taps, Gruvlok Fig. 7800, Grinnell Model 590, or equal.

H. Expansion Tank:

ET-1 Pressurized, vertical, steel expansion tank for non-potable water systems with a replaceable, heavy duty, Butyl rubber bladder, 1 inch or 1 1/2-inch NPT system connection, 3/4 inch drain, 0.302 inch-32 standard automobile tire valve type charging connection, lifting rings and a floor mounting skirt for vertical installation. The tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped for 125 psi working pressure. The tank must be also rated for a continuous working temperature of 240 degrees F. Provide weather and rust resistant coating.

Bell and Gossett, Wheatley, Taco, Amtrol, or equal.

I. Flow Control Valve – Manual:

FC-1 Flow control valves: Bell and Gossett Series CB circuit setter balancing valve, line size, with integral pointer (to register degree of valve opening), differential pressure meter connections with built-in check valves and lockable memory stops. Armstrong Series CBV circuit-balancing valves, Victaulic/TA Hydronics, or equal.

J. Venturi Flow Measuring Device:

FMD-1 Preso B-plus Series, Victaulic "Style 733", Griswold QuickSet Metering Stations, or equal, venturi type flow measuring device. Provide on the main heating hot water and chilled water lines and other locations as required for balancing, as indicated, between straight sections of pipe. Upstream pipe section shall be not less than 5 diameters in length and downstream section shall be not less than 2 diameters in length. Venturis shall be furnished complete with quick disconnect valves, safety shut-off with memory valves and attached metal identification tag.

1. 2-inch or smaller shall be furnished with threaded connections.
2. 2 ½-inch or larger shall be furnished with flanged or grooved connections.

K. Electronic Flow Readout Meter:

FM-1 Flow meter shall combine the functions and ranges of several gages into a single board range meter. Meter shall function as a compound pressure gage measuring the high side and low side pressure simultaneously and display each reading in sequence. Meter shall be furnished complete with a shut-off, bypass, and blow down valve network installed on a portable meter panel. A carrying case shall be provided with storage for accessories. Meter shall automatically select the proper range, compensate for temperature, and reset itself. Memory function shall store up to 90 sets of pressure and temperature. Pressure reading shall be accurate to plus or minus 2 percent of reading from 0.01 to 150 psi. Temperature readings shall be accurate to plus or minus 0.5 degrees F and plus or minus 1.0 degree F. from minus 65 degrees F to 250 degrees F. The flow metering device shall be Hydrodata Multimeter HDM-250 as manufactured by Shortridge Instruments Inc., or equal, and shall be furnished with pressure gage, portable meter panel and with valve network, carrying case, battery charger, instruction manual and certificate of calibration, two 6 feet long by 1/2 inch OD pressure hoses with quick disconnects, two 8 foot by 1/4 inch OD drain hoses, and a set of adapters.

L. Gate Valves:

1. Bronze, 2 inches and smaller:

GV-1 Class 125, 200 psi CWP, bronze body and bonnet non-rising stem, inside screw, screw-in bonnet, solid disc, threaded ends:

Hammond IB645, Crane 1701, Milwaukee 105, American 3F, NIBCO T-113, or equal.

GV-2 Same as GV-1, except solder ends:

NIBCO S 113, Milwaukee 115, Hammond IB 647, or equal.

GV-3 Class 125, 200 psi WOG, rising stem, inside screw, screw-in bonnet, solid disc, threaded ends:

Stockham B-100, Crane 428, NIBCO T-111, Milwaukee 148, Hammond IB-640, or equal.

GV-4 Same as GV-3 except solder ends:

NIBCO S-111, Milwaukee 149, Hammond IB-635, or equal.

GV-5 Class 125, 200 psi CWP, rising stem, union bonnet, solid disc, threaded ends:

Stockham B-105, Crane 428 UB, NIBCO T-124, Milwaukee 1152, Hammond IB-617, or equal.

GV-6 Class 150, 300 psi CWP, rising steam, union bonnet, solid wedge, threaded ends:

Crane 431 UB, Stockham B-120, NIBCO T-134, Milwaukee 1151, Hammond IB-629, or equal.

2. Iron Body Gate Valves; 2 1/2 inches and larger:

GV-7 Class 125, O S and Y, IBBM, bolted bonnet, solid disc, flanged ends:

Hammond IR1140HI, Stockham G623, Crane 465-1/2, NIBCO F-617-0, Milwaukee F 2885M, or equal.

GV-8 Class 250, 500 psi, CWP, O S and Y, IBBM, bolted bonnet, solid wedge flanged ends:

Crane 7-1/2E, NIBCO F-667-0, Hammond IR 1138 HI, Milwaukee F 2894 M, or equal.

M. Globe Valves:

1. Bronze, 2-inch and smaller:

GLV-1 Class 125, 200 psi, CWP, screw-in bonnet, Teflon disc, threaded ends:

Hammond IB440, Milwaukee 502, Stockham B-13-T, NIBCO T-211-Y, Crane 5TF, or equal.

GLV-2 Class 125, 200 psi, CWP, screw in bonnet, Teflon disc, solder ends.

Hammond IB-418, Milwaukee 1502, NIBCO S-211-Y, or equal.

GLV-3 Class 150, 300 psi, CWP, union bonnet, Teflon disc, threaded ends:

Hammond IB413T, Stockham B-22T, Milwaukee 590T, NIBCO T-235-Y, or equal.

GLV-4 Class 150, 300 psi, CWP, union bonnet, Teflon disc, soldered ends

Hammond IB423, Stockham B-24T, Milwaukee 1590T, NIBCO S-235-Y, or equal.

2. Iron Globe Valves, 2 ½-inch and larger:

GLV-5 Class 125, 200 psi, CWP, OS&Y, IBBM, renewable seat and disc, bolted bonnet, flanged ends:

Hammond IR116 HI, Stockham G-512, Crane 351, Milwaukee F2981 M, NIBCO F-718-B, or equal.

GLV-6 Class 250, OS&Y, IBBM, bolted bonnet, flanged ends:

Hammond IR 330 HI, Stockham F-532, Crane 21E, Milwaukee F2983M, NIBCO F-768-B, or equal.

N. Heater Vent Pipe:

1. Schedule Number:

HVP-1 Shall be UL approved for service specified. Concealed heater vent pipe, including pipe in or through attic spaces, shall be Los Angeles City approved double wall metal vent pipe. For recessed wall heaters, furnish B.W. type. All others may be Type B, or B.W. Clearances must comply with Los Angeles City code and conditions of UL listing.

American Metal Products Co., Inc., Simpson Dura-Vent, AmeriVent, Hart & Cooley Mfg. Co., Metalbestos, or equal.

O. Liquid Level Gage:

LLG-1 Refrigerant type, carbon steel with stainless steel trim or all forged steel construction, back-seating standard design. Upper and lower valve furnished with ball check valves; 1/2 inch diameter glass on center. Four 3/16 inch diameter gage glass guard rods or slotted steel guard.

Peneberthy, Henry, Conbraco, or equal.

P. Piping:

1. Piping shall be continuously and permanently marked with manufacturer's name, type of material, size, pressure rating, and the applicable ASTM, ANSI, UL, or NSF listing. On plastic pipe, date of extrusion must also be marked.

2. Underground non-ferrous pressure pipes shall be installed with proper color tracer wires. Refer to color code provisions in Section 23 0553: HVAC Identification.

3. Refer to HVAC Piping: Section 23 2013 for heating and chilled water piping and fittings.

Q. Pipe Isolators:

PLA-1 Absorption pad shall be not less than 1/2 inch thick, unloaded. Pad shall completely encompass pipe.

Holdrite, LSP, Stoneman, Potter-Roemer, Trisolator, PR-Isolator, or equal.

PLA-2 Plastic cushion to form an insulating liner and eliminate metal to metal contact when securing copper tubes and pipes in air conditioning and refrigeration insulation preventing galvanic erosion. (Acoustical Type for Sound Absorption)

Hydra-Zorb Cushion Clamps, LSP Products Group Acousto Clamp, or equal.

- R. Pressure Gage: Aluminum or steel case, minimum 4-1/4 inches dial; pressure type or combination vacuum-pressure type, with provisions for field calibration. Dial indicator to indicate pressure in psi with accuracy to within plus or minus 0.5 percent of maximum dial reading. Furnish gages with restriction screw, size 60, to eliminate vibration impulses. Black case and ring, bourdon tube of seamless copper alloy with brass tip and socket. Three way gage cock, constructed of brass with stuffing box, 1/2 inch couplings, with fixed or movable cap nut to shut off pressure gage.

PG-1 Pressure type, black drawn steel case, 4 1/2-inch glass dial, range approximately twice line pressure.

Marsh Keckley, Trerice, Weksler, Weiss, or equal.

- S. Safety Relief Valves:

SRV-1 Combination temperature and pressure relief type. CSA approved. Set to open at 125 psi pressure.

Watts 40L, Cash-Acme NCLX-1, Wilkins TP220, or equal.

SRV-2 Same as SRV-1, except provide on storage type water heater with anode in dip tube.

Watts 10 x L, CashAcme NCLX-1, Wilkins TP220, or equal.

SRV-3 Spring pop type, ASME and/or NB stamped and certified with manual lifting device for low-pressure steam boilers not exceeding 15 psig, and for hot water boilers and heaters operated at pressure not exceeding 160 psi or temperature not exceeding 250 degrees F. Outlet shall be one pipe size larger than inlet.

Crane, Bailey, Cash-Acme, Keckley, or equal.

- T. Strainers:

STR-1 Description: Wye type with monel or stainless steel strainer cylinder (manufacturer's standard mesh), and gasketed machine strainer cap. Where indicated on Drawings, provide with valved (globe valve) blowout piping, same size as blowout plug.

1. 2-inch and smaller:
C.M. Bailey No.100-A, 250 lb., cast iron body, threaded, Keckley 'B', Spirax Sarco Y-type, or equal.

2. 2 ½-inch and larger:

C.M. Bailey No.100-A, 125 lb., cast iron body, flanged, or Victaulic style 732, 300 psi, ductile iron body, grooved, fusion bonded epoxy coated.

C.M.Bailey, Armstrong, Muessco, Keckley 'A', or equal.

STR-2 Y pattern cast iron bodies, 125 psi, monel screen. Open area at least twice the cross-sectional area of IPS pipe in which strainer is installed and may be woven wire or perforated type. Screwed ends for sizes up to 2 inches, flanged ends fusion bonded epoxy coated for 2 1/2 inches and larger perforations, in accordance with the following:

1. Steam service - 40 square mesh.
2. Other services - 16 square mesh.

Bailey No.100, Armstrong, RP&C, Keckley, or equal.

U. Temperature Control Valves:

TCV-1 Motor-operated valve, Forged brass bodies rated at no less than 400 psi working pressure; Chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and TEFZEL characterizing disc.

Operated by Electronic Valve Actuator, manufactured, brand labeled or distributed by Belimo, TA, Honeywell, or equal.

TCV-2 Valves, automatic, electric, 3-way control.

Packed type bronze body and trim. Metal-to-metal seats designed for tight shut-off. Constant total flow throughout full plug travel. Valve designed for 150 psig steam working pressure. Valve operated by spring return motor with gear train. Valves screwed for sizes 2 inches and smaller.

Honeywell, Powers, Barber-Colman, Leonard, or equal.

TCV-3 Valves, automatic, electric, 3-way control.

Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, NPT female end fittings, with dual EPDM O-ring packing design, fiberglass reinforced Teflon flow characterizing disc. **[NPS ¾ inch and Smaller for Terminal Units: Nickel plated forged brass body rated at no less than 600 psi, chrome plated brass ball and blowout proof stem, NPT female fiberglass reinforced Teflon flow characterizing disc.]**

Belimo, Flow Control Industries, Inc., Delta Control Products, or equal

V. Thermometers

1. Industrial:

T-1 Straight type with fixed or ratable stem, extruded or cast brass or cast aluminum case and brass separable well 6 inches minimum scale, angle or straight type range 30 degrees - 240 degrees F.

Weksler, Terrice, Weiss, Ashcroft, Marshalltown, or equal.

T-2 Round type 3 ½-inch minimum dial range of 100 between 30 degrees and 155 degrees F, color coded red above 150 degrees F. Brass chrome plated case.
Ashcroft, U.S. Gage, Marsh, Weiss, or equal.

2. Remote:

T-3 Liquid-filled capillary type with bulbs as required for remote and insertion mounting dials of 3 ½-inch minimum diameter, non-ferrous internal parts, external means for re-calibration, glass or plastic lens and steel or non-ferrous case suitable for wall, duct or panel mounting range 30 degrees to 240 degrees F.

W. Traps:

TP-1 Steam, low-pressure (15 psig) float and thermostatic without strainers and with brass body (DZR) P-CuZn35Pb2 valves and Tefzel seats, for drips into gravity return, coils, etcetera.

Illinois	Hoffman	Sarco	Armstrong	Belimo	Equal
50 Series	860 Series			HTCCV series	

TP-2 Steam, low-pressure (15 psig), thermostatic for radiators and convectors, brass body (DZR) P-CuZn35Pb2 valves and Tefzel seats, cast iron body

Webber Series 5, Sarco 17C, 8C, 9C, Hoffman, Armstrong, Belimo HTCCV series, or equal.

X. Valves (Air Vent):

VAV-1 Hot or chilled water air release valves shall be cast brass rated for 150 psig design pressure and 270 F operating temperature.

Spirotherm, Bell & Gossett, Taco, or equal.

VAV-2 Hot or chilled water space heating system air valve, brass with nickel trim 1/4 inch connection, disc type for manual or automatic venting.

Hoffman 500, Spirotherm, Watts, or equal.

VAV-3 Brass petcock, 1/4 inch connection by 1/4 inch copper tube to high point of coil or line by means of a tapped cap on top of 6 inches vertical nipple. Petcock to be installed approximately 5 feet 6 inches above finish floor.

Amtrol, Watts, Dole, or equal.

Y. Vacuum Valves:

VV-1 Vacuum valves; for vacuum serve, 125 psig working pressure, cast iron body, spring loaded lubricated plug type.

General Controls, Honeywell, Val-Matic, or equal.

- Z. Flanges: Flanges shall be furnished and installed at each flanged connection of each type of equipment, tanks, and valves. Faces of flanges being connected shall be

furnished alike. Connection of a raised face flange to a flat-faced flange is not permitted. Flanges shall conform to following schedules:

TYPE OF PIPE	FLANGE
Screwed black or galvanized grooved steel pipelines.	125 pound black cast iron screwed flange, flat faced or grooved flange adapters, Victaulic Style 741, Tyco-Grinnell Fig. 71, Gruvlok Fig. 7401, or equal.
Welded or grooved steel pipe, except high pressure steam lines.	150 pound black forged steel welding flanges, 1/16 inch raised face ASTM A105, Grade II or grooved flange adapters, Victaulic Style 741, Tyco-Grinnell Fig. 71, Gruvlok Fig. 7401, or equal.
Copper and brass pipe or tubing.	150 pound cast bronze, flat-faced flange with solder end or grooved flange adapters, Victaulic Style 641, Tyco-Grinnell Fig. 61, Gruvlok Fig. 6084, or equal.

1. Gasket material for flanged connections shall be full faced or ring type to suit facing on flanges and shall be furnished in accordance with following schedule

SERVICE	TYPE
Cold water	1/16 inch thick neoprene
Steam, hot water	1/16 inch Teflon

Grooved end flange adapters supplied with pressure responsive elastomeric Gaskets supplied with grooved flange adapters shall be pre-lubricated by the manufacturer. Grade of gasket to suit intended service.

AA. Unions:

1. Unions shall be furnished and installed in accordance with the following requirements (unless flanges are furnished):
 - a. At each threaded or soldered connection to equipment and tanks, except in Freon or fuel gas, piping systems, whether indicated or not.
 - b. Immediately downstream of any threaded connection to each manually operated threaded valve or cock, and each threaded check valve, yard box or access box except those in Freon piping systems, whether indicated or not.
 - c. At each threaded connection to threaded automatic valves (except those in Freon piping systems) such as reducing valves and temperature control valves, whether indicated or not.
 - d. If grooved piping is used, couplings shall serve as unions. Additional unions are not required
2. Unions shall be located so that piping can be easily disconnected for removal of equipment, tank, or valve.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which Work of this Section shall be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

3.02

INSTALLATION

- A. Provide all materials and equipment for the Work. Furnish and install necessary apparatus, parts, materials, and accessories.
- B. Pipe Installation:
 - 1. Install piping parallel to wall and provide an orderly grouping of proper materials and execution.
 - 2. Piping shall clear obstructions, preserve headroom, provide openings and passageways clear, whether indicated or not. Verify the Work of other Divisions to avoid interference.
 - 3. If obstructions or the Work of other Divisions prevent installation of piping or equipment as indicated by the Drawings, perform minor deviations as required by the Architect.
 - 4. Install piping after excavation or cutting has been performed. Piping shall not be permanently enclosed, furred in, or covered before required inspection and testing is performed.
 - 5. Exposed polished or enameled connections from fixtures or equipment shall be installed with no resulting tool marks or threads at fittings. Residue or exposed pipe compound shall be removed from exterior of pipe.
 - 6. Piping shall be concealed in chases, partitions, walls, and between floors, unless otherwise directed or specifically noted on Drawings. When penetrating wood studs, joists, and other wood members, provide such members with reinforcement steel straps of Continental Steel & Tube Co., ULINE, Independent Metal Strap, or equal.
 - 7. Reduce fitting where any change in pipe size occurs. Bushings shall not be furnished unless specifically reviewed by the Architect, or indicated on Drawings.
 - 8. Piping subject to expansion or contraction shall be anchored in a manner, which permits strains to be evenly distributed. Swing joints or expansion loops shall be installed. Seismic restraints shall be installed so as not to interfere with expansion and contraction of piping. Seismic loops required at all building separations.
 - 9. Immediately after lines have been installed, openings shall be capped or plugged to prevent entrance of foreign materials. Caps shall be left in place until removal is necessary for completion of installation.

10. Couplings shall not be installed except where required pipe runs between other fittings are longer than standard length of type of pipe being installed and except where their installation is specifically reviewed by the Architect.
11. Water piping shall be installed generally level, free of traps, unnecessary offset, arranged to conform to building requirements, clear of ducts, flues, conduits, and other Work. Piping shall be arranged with valves installed to provide for complete drainage and control of system. Piping shall not be installed which causes an objectionable noise from flow of water therein under normal conditions. Refer to Section 23 0500: Common Work Results for HVAC.
12. Water lines may be installed in same trench with sewer lines, provided bottom of water line is 12 inches minimum above top and to the side of sewer line.
13. Hot and chilled water circulating piping installed for space heating or cooling shall pitch up to a high point at a slope of 1/4 inch in 10 feet in the direction of flow. Where supply and return lines are exposed, both lines shall pitch in same direction. Otherwise, where possible, lines shall pitch up toward compression tank.
14. Changes in pipe sizes shall be furnished with eccentric reducers, flat on top. Offsets to clear obstruction shall not be installed so as to produce air pockets.

C. Pipe Sleeves and Plates:

1. Provide and install pipe sleeves of Schedule 40 black steel pipe or Schedule 40 PVC plastic pipe in concrete or masonry walls, footings, and concrete floors below grade. Provide and install adjustable submerged deck type sleeves at locations where pipes pass through concrete floors, except concrete slab floors on grade, and at locations where soil pipe for floor type water closets passes through concrete floors.
2. Sleeves shall provide 1/2 inch clearance around pipes, except plastic pipe shall have 1-inch clearance. Caps of deck type sleeves shall be removed just prior to installation of pipe. Area around sleeves shall be smooth and without high or low spots. Sleeves in walls shall not extend beyond exposed surface of wall. Sleeves in concrete floors and walls shall be securely fastened to forms to prevent movement while concrete is being placed.
3. Piping installed on a roof shall clear the roof surface by 10 inches minimum, with or without insulation. Bottom of individual fittings may infringe on 10 inches clear space but not groups of fittings or fittings located within 27 inches of each other.
4. Stiles shall be provided to facilitate crossing of piping when parallel piping runs are laterally greater than 12 inches out-to-out, or any pipe is higher than 18 inches, and more than 40 feet long or runs between 2 or more major pieces of equipment or housings greater than 20 feet apart. Stiles shall be not less than 20 inches wide with a minimum tread depth of 10 inches. Where stiles are required, they shall be located so greatest obstructed distance is 30 feet.

5. Where pipes pass through waterproofed walls, floors, or floors on grade, sealant with Link-Seal Modular Seals, or equal, between pipe and sleeve to provide a waterproof joint. Where earth is in contact with pipe on both sides of a wall or foundation, the waterproof joint is not required. Commercial rubber compression units may be furnished instead of sealed sleeves if reviewed by the Architect.
6. A swing joint, or other required device, shall be furnished and installed in hot water lines with 10 feet of sealant or compression joint to allow for expansion.
7. Pipe sleeves shall be provided where pipes intersect footings or foundation walls and sleeve clearances shall provide for footing settlement, but not less than one inch all around pipe.

D. Welding of Pipe and Qualifications of Welder:

1. Joints above grade or accessible conduit or tunnels in steel piping may be either welded or screwed unless specifically indicated otherwise on Drawings or specified. Joints in below grade steel piping, whether in insulation or not, shall not be welded, unless otherwise indicated.
2. Welded joints in pipe shall be continuous around pipe and shall comply with ASME B31: Code for Pressure Piping, unless otherwise specified.
3. Each pipe weld shall be stamped with welder's identification mark. Welding shall be performed by welders possessing a valid certificate of qualification for welding carbon steel welding pipe in horizontal position (2G) and horizontal fixed position (5G) in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code, by an Owner-recognized, DSA approved testing laboratory.
4. Before any welder performs welding on the Work, furnish the Project Inspector with a copy of welder's valid qualification papers and obtain verification. Welder qualification is not valid unless it has been issued while welder was performing work for current employer, and has performed type of work described by qualification in the preceding 3 months.
5. Welding performed under these Specifications is subject to special tests and inspections including rigid Ultra Sonic Testing (UT) and radiographic inspection at random, in accordance with Technique for Radiographic Examination of Welded Joints by an Owner recognized, DSA approved testing laboratory.

E. Unacceptable Welds and Repairs to Welding:

1. Welds containing any of the following types of imperfections shall be deemed defective Work:
 - a. Cracks of any type.

- b. Zones of incomplete (in excess of 1/32 inch) fusion or penetration.
 - c. Elongated slab inclusions longer than 1/4 inch.
 - d. Groups of slag inclusions in welds having an aggregate length greater than thickness of parent metal in a length 12 times the thickness of the parent metal.
 - e. Undercuts greater than 1/32 inch.
 - f. Overlaps, abrupt ridges or valleys.
2. When a defective weld is detected by examination as outlined above, two additional welds shall be radiographed at locations selected by the Project Inspector. If the two selected welds demonstrate compliant welding, then the two tested welds shall be deemed to be in compliance. Welding revealed by radiographs to be defective Work shall be removed, repaired, and tested by radiograph.
 3. If either of the two selected welds demonstrates welding deemed to be defective Work, all welding in that portion of the Work shall be deemed defective Work and either: all welds shall be cutout, prepare new ends for welding and weld to comply with this Specification, or radiograph all welds, removing and repairing only such welding deemed to be defective Work.
 4. Repair welding shall be performed in a manner in full compliance with ASME B31. The welded joints or repairs shall be spot examined with UT or radiographic tests in accordance with foregoing requirements.
 5. Owner shall cause to be performed additional random UT and radiographic examinations of welds. Owner shall be responsible for the costs of any UT and radiographic examinations found to be in compliance with specified requirements.
 6. Installer shall be responsible for the costs of UT and radiographic re-examinations of welds deemed defective Work and not in compliance with this Specification, and shall repair or replace said welds in accordance with specified requirements.
- F. Welding Rods: Submit a written list of materials and proposed type of welding rods for review by the Architect.
 - G. Backing Rings: Backing rings may be submitted for installation provided the Product Data is submitted with the material list.
 - H. Qualification Tests for Low-pressure Welding:
 1. Tests shall be performed on 3-inch standard weight pipe ASTM A53, Grade A, and shall be welded by acetylene and electric arc. Each sample shall consist of two pieces, each 10 inches long, with 30-degree bevel at point weld.

2. Two 20-inch samples shall be performed in the 2G and two 20-inch samples in the 5G positions, with positions defined in Section IX, ASME

Boiler and Pressure Vessel Code. Welds shall have the reinforcement ground or machined flush to the surface of the pipe before testing. Samples shall be tested as full section tensile.

3. Weld shall develop a load of 90 percent of 50,000 psi, i.e., 45,000 psi or shall develop a fracture in parent metal.
4. Each qualified welder shall carry an identification card listing welder's name, date of test, and type of welding tests passed; signed by the welder and the laboratory.
5. A valid certificate of qualification issued in compliance with requirements of the ASME Boiler Pressure Vessel Code Section IX shall qualify a welder for issuance of a certificate for low-pressure pipe welding.

I. Certificates of Qualification for Welding of Unfired Pressure Vessels:

1. Certificates of qualification shall be issued by a laboratory recognized by the Owner in compliance with the requirements of the ASME Boiler Pressure Vessel Code Section IX. Qualifications shall be for both acetylene and arc welding of Schedule 40 ASTM A53, Type B, steel welded or seamless pipe in the Horizontal Position (2G) and the Horizontal Fixed Position (5G) as defined by said code.

NOTE: Certificate described above is not valid unless it has been issued while welder was working for his current employer, and unless welder has performed type of work described by certificate in the preceding three months. Requirements for possession of a valid certificate shall not be waived for welders fabricating unfired pressure vessels when the Specifications require compliance with ASME code or when welding pipe carries working pressures greater than 75 psi and temperatures greater than 250 degrees F.

J. Pipe Joints and Connections:

1. Pipe and tubing shall be cut per IAPMO Installation Standards. Pipe shall have rough edges or burrs removed so that a smooth and unobstructed flow shall be provided.
2. Threaded Pipe: Joints in piping shall be installed according to the following service schedule:
 - a. Refrigerant and Soap Piping: Litharge and glycerine, or Expando, Gasoila, or equal.
 - b. All other services Furnish sealant, suitable and as reviewed by the Architect.
3. Threads on pipe shall be cut with sharp, clean, unblemished dies and shall conform to ANSI/ASME B1.20.1 for tapered pipe threads.

4. Joint compounds shall be smoothly placed on male thread and not in fittings. Threaded joints shall be installed tight with tongs or wrenches and sealant of any kind is not permitted. Failed joints shall be replaced with new

materials. Installation of thread cement or sealant to repair a leaking joint is not permitted.

5. Sharp-toothed Stillson, or similar wrenches, is not permitted for the installation of brass pipe or other piping with similar finished surfaces.

K. Copper Tubing and Brass Pipe with Threadless Fittings:

1. Silver brazed joints shall be used for attaching fittings to non-ferrous metallic refrigerant piping.
2. Non-pressure gravity fed condensate lines may be soldered with 95/5 solder.
3. Silver brazing alloy, Class BCUP-5. Surfaces to be joined shall be free of oil, grease, and oxides. Socket of fitting and end of pipe shall be thoroughly cleaned with emery cloth and wiped to remove oxides. After cleaning and before assembly or heating, flux shall be installed to each joint surface and spread evenly. Heat shall be applied in accordance with instructions in the Copper Tube Handbook issued by Copper Development Associates. Joints constructed of rough bronze fittings shall be provided as recommended by manufacturer.
4. Do not overheat piping and fittings when installing silver brazing.
5. Joints in non-ferrous piping for services not covered above shall be installed with solder composed of 95/5 tin/antimony, ASTM B32, Grade 5A. Surfaces to be jointed shall be free of oil, grease, and oxides. Sockets of fitting and end of pipe shall be thoroughly cleaned with emery cloth to remove oxides. Solder flux shall be sparingly installed and solder added until joint is completely filled. Do not overheat. Excess solder, while plastic, shall be removed with a small brush in order to provide an uninterrupted fillet completely around joint. Random inspection of joints shall be conducted by Project Inspector to ensure joints are lead-free.
6. Grooved end joints for copper piping shall be assembled in accordance with the latest manufacturer recommendations. Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. Grooving tools shall be as manufactured by Victaulic, RIDGID, MAG Tool, or equal.

- L. Ring-Type Pipe: Joints shall be installed in accordance with manufacturer's instructions with grooved couplings, fittings and rubber rings. Couplings and pipe shall be compatible and of the same manufacturer. Rings shall be accurately located and installed by grooves in coupling. Pipe shall be installed with zero deflection unless otherwise specified. Pressure pipe shall be furnished with thrust blocks at each offset point.

M. Welded Pipe Joints:

1. Joints in welded steel pipelines shall be installed by oxyacetylene or electric arc process. Welding shall be continuous around pipe and provided as specified.
2. Butt welds shall be of the single V-type, with ends of pipe and fittings beveled approximately 37 ½ degrees. Piping shall be aligned before welding is started with the alignment maintained during welding.
3. Welds for flanges and socket fittings shall be of the fillet type with a throat dimension not less than pipe wall thickness.

N. Grooved End Pipe Joints: Grooved end joints for carbon steel piping shall be assembled in accordance with the latest manufacturer recommendations. Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. Grooving tools shall be as manufactured by Victaulic, RIDGID, MAG Tool, or equal.

O. Joints shall be Vic-Press 304TM, or equal, made with Victaulic Series 'PFT' tools and the appropriate sized jaw. Pipe shall be certified for use with Vic-Press 304TM system, and shall be square cut, properly deburred and cleaned, and marked at the required location to insure full insertion into the fittings and/or couplings.

P. Valves: Valves shall conform to the following:

1. Piping systems shall be furnished with valves at points indicated on Drawings and specified, arranged to provide complete regulating control of piping system throughout building and the Project site.
2. Valves shall be installed in a neat grouping, so that parts are easily accessible and maintained.
3. Pressure Independent Characterized Control valve type shall be suitable for service on which installed.
4. Valves shall be full size of line in which they are installed, unless otherwise indicated on Drawings or otherwise specified, and shall be one of types specified.
5. Provide chain operators on valves 2-inch and larger located 7 feet or more above the servicing floor level.
6. Valves for similar service shall be of one manufacturer.
7. Except where otherwise specified, valves shall be Belimo, Victaulic, Stockham, Crane, Jenkins, Milwaukee, Hammond, American Valve, NIBCO, Hoffman, or equal.

8. Ball valves below grade in yard boxes shall have stainless steel handles.
9. Temperature relief valves and combination temperature and pressure relief valves shall be as specified and furnished as set forth in this Section. Discharge pipe from relief valves shall be not less than discharge area of

valve or valves it connects, based on discharge area of valves, and shall terminate as indicated and free of any traps. Valves shall be installed at following locations:

- a. A combination temperature and pressure relief valve or combination of valves on each heating hot water boiler. Temperature sensing element shall extend into water inside boiler.
10. Manual air vent valve assemblies shall be installed at each high point of hot water space heating and chilled water piping systems. Valves shall discharge through 1/4 inch diameter copper tubing and drain to nearest floor sink. Automatic type air vent valve shall only be installed where specifically indicated. Radiator, convectors, and finned pipe convectors shall be fitted with packless radiator valves, angle or straight pattern. Each convector or radiator installed as part of a space hot water heating system shall be furnished with a manual-type air vent valve.
- Q. Strainers: Strainers shall be installed on each water main (except for fire line) downstream of the meter, above grade, when a pressure regulator assembly is not installed. Main strainer shall be of Y-flange or groove type. On closed loop chilled and heating hot water systems pump systems, a strainer shall be installed at each pump inlet and upstream of each flow control valve assembly. The control valve assembly may include a modulating temperature control valve and a flow-limiting valve, manufactured by Griswold, AutoFlow, Flow Control Industries, Inc., or equal.
- R. Hangers and Supports:
1. Piping shall be securely fastened to building structure by approved iron hangers, supports, guides, anchors, and sway braces to maintain pipe alignment to prevent sagging and to prevent noise or excessive strain on piping due to uncontrolled or seismic movement under operating conditions. Hangers and supports shall conform to Manufacturer's Standardization Society Specification SP-69. Hangers shall be relocated as required to correct unsatisfactory conditions that may become evident when system is placed into operation. Appliances, heat exchangers, storage tanks, and similar equipment shall be securely fastened to structure in accordance with seismic requirements. Outdoor metal hangers and supports shall be hot-dipped galvanized steel, unless otherwise specified.
 2. Piping shall not be supported by wire, rope, wood, plumbers' tape, or other non-recognized devices.
 3. Hangers and supports shall be designed to support weight of pipe, fittings, weight of fluid and weight of pipe insulation, and shall have a minimum factor of safety of 5, based on ultimate tensile strength of material installed.

4. Burning or welding of any structural member under load is not permitted. Field welding not specified on Drawings or reviewed Shop Drawings is not permitted without review by Architect and DSA.
5. Burning holes in beam flanges or other structural members is not permitted without review by the Architect and DSA.
6. Pipe hangers on piping covered with low temperature insulation shall be installed on outside of insulation and not in contact with pipe unless otherwise detailed on Drawings. Insulation shall be protected by 18 gage galvanized steel shield, with a minimum length of 10 inches, installed completely around pipe covering between covering and hanger. Installing hangers directly on pipe and butting adjoining sections of insulation against hanger is permitted provided void and hanger rod are properly insulated and sealed so that no sweating occurs at hangers.
7. Hanger rods shall be fastened to structural steel members with suitable beam clamps. Clamps shall be Tolco, Carpenter & Patterson, Fee and Mason, or equal, as follows:
 - a. Tolco I beam, Fig.62 for maximum 1000 lbs.
 - b. Tolco I or WF beam, Fig. 329, for maximum of 1290 lbs.
8. Hanger rods shall be fastened to concrete inserts in concrete slabs or beams. Inserts shall be Tolco, Carpenter & Patterson, Fee and Mason, or equal, as follows:
 - a. Tolco Fig.310 for maximum of 600 lbs.
 - b. Tolco Fig. 309 for maximum of 1140 lbs.
9. For fastening to wood ceilings, beams, or joists, furnish Anvil Fig. 128R, Anvil Fig. 153, Tolco 78, or equal pipe hanger flange fastened with drive screws. Under wood floors, 3/8 inch hanger rods shall be hung from 2-inch by 2-inch by 1/4 inch angle clips 3-inch long, with two staggered 10d nails, clinched over joist.
10. Hanger rod sizes for copper, iron, or steel pipe: 3/8 inch for pipe sizes 1/2 inch through 2-inch, 1/2 inch for pipe sizes 3-inch, 4-inch and 5-inch, 5/8 inch for pipe size 6-inch, and 3/4 inch for 8-inch and 10-inch pipe.
11. Turnbuckles, if furnished, shall provide a load carrying capacity equal to that of the pipe hanger with which they are being installed.
12. Pipe hangers shall be of same size, or nearest larger manufactured size available, as pipe or tubing on which they are being installed.
13. Hangers, clamps, and guides furnished for support of non-metallic pipe shall be padded with 1/8 inch thick rubber, neoprene, or soft resilient cloth.

14. Where special pipe-supporting requirements in the Specifications conflict with any standard requirements specified herein, the Specification requirements shall govern.
15. Vertical Piping:
 - a. Vertical pipe risers shall be securely supported with riser clamps of recognized type. Risers in reinforced concrete buildings shall be

furnished with extension clamps fastened to pipe above each concrete floor slab with extended arms of clamp to rest on slab. Clamps shall be provided with lead or Teflon liners when installed on copper tubing. Clamps shall be plastic-coated when installed on non-ferrous pipe or tubing.
 - b. Copper tubing in sizes 1 ½-inches and larger and steel pipelines passing up through building shall be supported at each floor of building or every 15 feet whichever is less.
 - c. Copper tubing sizes 1 ¼-inch and smaller shall be supported at not intervals not more than 6 feet on center. Special provisions shall be installed for vertical lines subject to expansion and contraction caused by operating temperature differences.
 - d. Vertical cast iron pipelines shall be supported from each floor and at its base. Malleable iron or steel pipe clamps with minimum thickness of 1/4 inch shall be furnished and fastened around pipe for support.
16. Horizontal Piping:
 - a. Roof Mounted Piping: Pressure and non-pressure piping shall be supported from channels, stands, clamps, trapezes, rollers, or structures mounted on 100% rubber, UV resistant rooftop supports with reflective strips, Dura-Block, or equal. Roller type supports shall be provided below and above pipe to prevent its dislodgement. Bottom of pipes shall clear the roof surface by 10 inches.
 - 1) At PVC roofing provide walk tread, polyester reinforced, UV resistant, with surface embossment at rooftop supports. Heat welding of walk pads shall only be done by manufacturer certified installers.
 - a) Sika-Sarnafil and Carlisle: Walk tread shall be no more than one inch larger than the plan area of the pipe support blocks and adhered to the roof membrane with Sika 1A or Carlisle Universal Single-Ply sealant, as applicable.
 - b) Johns Manville: Walk tread shall be installed under the pipe support blocks and adhered to the blocks, if possible, and left loose laid on top of the PVC roof

system. waik-pad shall have a minimum of 4 inches of material past perimeter on all 4 sides of block.

- 2) Built-up roofing: Provide APP granulated modified torch-down at each pipe support block. Torch-down shall extend 2 to 4 inches beyond the edges of the block and adhered by torch application over existing cap sheet membrane. This work shall be performed by a certified roofer.

b. Piping Mounted to Underside of Roof and Decks and from Structure:

1. Insulated steam and space heating hot water supply and return piping shall be supported with Tolco Figure 4, B-Line Figure B3140, Anvil Figure 212, or equal, steel hangers with welded eye rods to permit hinge movement at point of attachment of hangers. Hinge movement at point of support shall be provided by welded eye linked rods Tolco Figure 101L, B-Line Figure B3211X, Anvil Figure 278X, or equal.
2. Chilled water supply and return piping, condenser water piping, insulated refrigerant piping may be supported with Tolco Figure 1, B-Line Figure B3100, Anvil Figure 260, or equal, hangers with rods, turnbuckles and inserts suitable for above hangers.

c. Maximum hanger and support spacing shall conform to CPC schedule for horizontal piping installed above grade.

17. A hanger or support shall be installed close to the point of change in direction of a pipe run, in either a horizontal or vertical plane.
18. When practicable, supports and hangers for cast iron soil pipe shall be installed as close as possible to joints and when hangers or supports are not located within one foot of a branch line fitting, an additional hanger or support shall be installed at fitting.
19. In systems where grooved piping is used, couplings shall be provided with angle pattern bolt pads to comply with support and hanging requirements of ANSI/ASME B31.1, ANSI/ASME B31.9, and NFPA Pamphlet 13.

S. Flashings:

1. Each pipe, duct, or gas-fired equipment vent passing through roof shall be installed with waterproof flashing.
2. Flashing or flanges on pipes, vents, and ducts passing through a tile or slate roof shall be constructed of sheet lead. Flashing for pipes and heater vents passing through a roof shall be 4 pound soft sheet lead. Flashing and flanges for ducts and heater vents passing through exterior walls shall be 22 gage sheet metal. Flanges and flashing shall be installed waterproof at point of

connection with pipe or duct. No soldered joints on roof flashings will be allowed.

3. Lead flashing and flanges shall be constructed of 4 pound sheet lead with burned joints. Flange of lead flashing or lead flange on a duct shall extend out onto roof a minimum of 12 inches from pipe or duct. Lead flashing shall extend up the pipe or duct not less than 7 inches.
 4. Sheet metal flashing shall be constructed of 24 gage galvanized sheet steel. Flanges on these flashings shall extend out onto roof a minimum of 10 inches from pipe or duct. Flanges on ducts through exterior walls shall extend out from duct a minimum of 2 ½ inches. Flanges on gas-fired equipment single-wall vents shall be of ventilated type. Type B gas vents through a roof shall be furnished with non-ventilated flashing as per NFPA Pamphlet 211.
 5. Cast iron, steel, brass, and copper pipe, which terminate less than 18 inches above roof, shall be furnished with a combination counter-flashing and vandal-proof hood for protection against water, birds and foreign matter. Cast iron, steel, brass and copper pipe, which does not terminate within 18 inches of roof, shall be furnished with a counter-flashing sleeve. Pipe, which terminates more than 18 inches above roof, shall be furnished with protection against entrance of water, birds, and foreign matter.
 6. Counter-flashing and combination counter-flashing sleeves and vandal-proof hoods shall be cast iron, vandal-proof, threaded, sealed or approved gas-heated sleeve type. Counter-flashing sleeves on each of these items shall extend down over flashing a minimum of 3/4 inch.
 7. Flashing and flanges on ducts shall be installed waterproof at point of connection to the duct by riveting and soldering. Storm collars shall be securely screwed and installed waterproof around appliance vent pipe immediately above flashing.
 8. Vent piping above roof shall be furnished with a combination counter-flashing sleeve and vandal-proof hood.
- T. Equipment Installation: Install roof or floor mounted equipment on level platforms, housekeeping pads or curbs and provide sound, vibration and seismic control measures per Section 23 0548, unless indicated otherwise whether indicated on drawings or not.

END OF SECTION

SECTION 23 0553
HVAC IDENTIFICATION

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Marking and identification required on mechanical piping systems, ducts, controls, valves, apparatus, etcetera.
- B. Related Requirements:
 - 1. Division 01: General Requirements.
 - 2. Section 23 0513: Basic HVAC Materials and Methods.
 - 3. Section 23 0900: HVAC Instrumentation and Controls.
 - 4. Section 23 2013: HVAC Piping.
 - 5. Section 23 3000: Air Distribution.
 - 6. Section 23 6416: Oil Lubricated Centrifugal Water Chillers.
 - 7. Section 23 6418: Oil Free Centrifugal Water Chillers.
 - 8. Section 23 6423: Scroll Water Chillers.
 - 9. Section 23 6426: Rotary-Screw Chillers.
 - 10. Section 23 6428: Air-Cooled Rotary Screw Chillers.
 - 11. Section 23 6500: Cooling Towers.
 - 12. Section 23 8000: Heating, Ventilating and Air Conditioning Equipment.

1.02 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 0500: Common Work Results for HVAC.
- B. Submit product data and installation instructions for each item specified.
- C. Submit Samples of materials.

1.03 QUALITY ASSURANCE

- A. Comply with provisions of:

1. Section 23 0500: Common Work Results for HVAC.
2. ANSI/ASME A13.1: Scheme for the Identification of Piping Systems.
3. APWA: Uniform Color Code.

Or
4. IAPMO: Uniform Plumbing Code (UPC).

PART 2 – PRODUCTS

2.01 MATERIALS

- A. General: Piping systems, controls, valves, apparatus, etc., except those that are installed in inaccessible locations in partitions, walls, and floors, shall be permanently identified.

2.02 VALVES

- A. Furnish prepared chart or diagram for each piping system, indicating by identifying letter or model number of each valve in the system, its location, and function.
- B. Install charts in aluminum frame with clear glass front and secure on wall where designated by the Project Inspector.
- C. Bind copies of each chart in operating instructions manual.
- D. Provide each valve with a brass, aluminum, or plastic disc, not less than 1-1/4 inches diameter bearing engraved numbers corresponding to those indicated on chart. Fasten discs to valve with No. 14 brass wire.
- E. Provide an additional tag for safety valves and other valves that could be hazardous to safety and health of occupants. Distinguish these tags from regular valve tags by color (such as yellow with black letters, and marked "Danger"); submit Sample tag to the Architect for review.

2.03 INSTRUMENTS AND CONTROLS

- A. Identify panel-mounted instruments and controls with engraved bakelite nameplates permanently affixed to panel boards.
- B. Identify alarm indicating devices and alarm reset devices by nameplates.
- C. Identify damper motors and automatic valves, flow switches, pressure switches, etc., with embossed aluminum or plastic tape affixed to controller, indicating service and setting.

2.04 EQUIPMENT

- A. Identify each major piece of equipment with engraved bakelite nameplates permanently affixed to the equipment, indicating the room numbers it services, Equipment identification designation shall be the same to its designation indicated on the "As-Built Drawings". Room numbers in the nameplates shall correspond to the final room numbers.

2.05 ABOVE GRADE PIPE IDENTIFICATION

- A. Identify pipes by means of colored labels with directional flow arrows and identification of the pipe content, in conformance to ANSI/ASME A13.1 or the UPC.
- B. Materials: Precoiled acrylic plastic with clear polyester coating, all-temperature, self-adhering, as manufactured by Brady, Brimar Industries, Seton, Stranco, Inc., or equal.

- C. Size:

Outside Diameter of Pipe or Insulation	Length of Color Field	Size of Letter
¾ to 1 ¼-inch	8-inch	½-inch
1 ½ to 2-inch	8-inch	¾-inch
2 ½ to 6-inch	12-inch	1 ¼-inch"
8 to 10-inch	24-inch	2 ½-inch"
over 10-inch	32-inch	3 ½-inch

- D. Colors: As indicated in schedule.

- E. Locations:

1. On accessible piping, whether insulated or not (including mechanical rooms, attic and ceiling spaces); except that labels shall be omitted from piping where contained material is obvious due to its connection to fixtures (such as faucets, water closets, etc.).
2. Near each valve and branch connection in such accessible piping.
3. At each pipe passage through wall or floor.
4. At not more than 20 feet spacing on straight pipe run between bands required in 2 and 3 above.
5. At each change in direction.

- F. Application: Install on clean surfaces free of dust, grease, oil, or any material that will prevent proper adhesion. Replace non-adhering or curling labels with new labels, as required by the Project Inspector.

G. Schedule:

Content of Pipe	Legend	Background Color	Lettering Color
Steam	Steam	Yellow	Black
Steam condensate	Stm. Cond.	Yellow	Black
Chilled water supply	Chill water supply	Green	White
Chilled water return	Chill water return	Green	White
Instrument air	Inst. Air	Green	White
Heating hot water supply	Heating hot water supply	Yellow	Black
Heating hot water return	Heating hot water return	Yellow	Black
Air conditioning condensation drain	A/C condensate drain	Green	White

2.06

UNDERGROUND PIPE

A. Detectable Marking Tape:

1. Provide and install detectable marking tape along buried piping. Tape shall be specifically manufactured for marking and locating underground utilities with electronic equipment. Tape shall be acid and alkali resistant, and manufactured with integral wires or foil backing, encased with protective cladding. Tape shall be a minimum of two inches in width.
2. Manufacturer: Reef Industries, Inc., Advantage Brands, Inc., Northtown Company, Mutual Industries, Inc., or equal.
3. Detectable marking tape shall be color-coded per APWA Color Code:
 - a. Yellow: Steam.
 - b. Blue: Water.
 - c. Red: Electric power lines, cables, conduit and lighting cables. By Division 26.
 - d. Orange: Communication, alarm or signal cables. By Divisions 26 and 27.

B. Tracer Wire:

1. Solid copper wire type THWN, 12 AWG gage, with heat and moisture resistant insulation.

2.07

IDENTIFICATION OF AIR CONDITIONING EQUIPMENT

- A. Provide identification markers to locate air conditioning equipment above T-bar ceilings. Install 3/4 inch to one inch diameter colored self-adhesive dots to T-bar ceiling grid

indicating point of access. The following identification markers shall be recorded on the project record documents:

1. Fire Damper and Combination Fire/Smoke Fire Damper: Red.
2. Manual Volume Dampers, Relief Dampers, Motorized Volume Dampers: Blue.
 - a. Supply air: Full dot.
 - b. Return air: Half dot.
3. Fan coil unit: Green.
4. Filter Location if separate from fan coil: Yellow.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Correct detrimental conditions prior to commencing the Work of this Section. Install markers and identification tags as specified with materials and installation procedures recommended by manufacturer.
- B. Place tracer wire on top of non-metal utility lines allowing some slack. Do not wrap tracer wire around pipe. Fasten tracer wire in place at approximately 10 feet on centers with non-metal ties.
- C. Install underground detectable pipe marking tape continuously buried 8 to 10 inches above the buried utility pipe. Wrap tape on pipe risers up to a height of 12 inches above grade.

3.02 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. TAB for the following:

1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - c. Induction-unit systems.
2. Balancing Hydronic Piping Systems:
 - a. Variable-flow hydronic systems.
 - b. Primary-secondary hydronic systems.
3. Balancing steam systems.
4. TAB Equipment:
 - a. Heat exchangers.
 - b. Motors.
 - c. Heat-transfer coils.
5. TAB existing systems and equipment.
6. Duct leakage tests.
7. Control system verification.
8. Testing plan and balancing procedure to be provided with submittal.

1.2 QUALITY ASSURANCE

- A. TAB Agent Qualifications:** AABC certified.

1.3 EXECUTION

- A. Tolerances:** Plus or minus 10 percent of design values.
- B. Inspections:** Random checks by TAB firm to verify final TAB report.
- C. Additional Tests:** Random tests within 90 days of completing TAB to verify balance conditions and seasonal tests.

END OF SECTION

**SECTION 23 0700
HVAC INSULATION**

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Condensate drain piping from air conditioning equipment.
2. Vacuum and condensate pump discharge lines over 50 feet in length.
3. High and low temperature equipment.
4. Heating hot water supply and return piping.
5. Chilled water supply and return piping.
6. Refrigerant piping.
7. Supply and return air ducts for heating and cooling systems air ducts.

B. Related Requirements:

1. Division 01: General Requirements.
2. Section 23 0500: Common Work Results for HVAC.
3. Section 23 0513: Basic HVAC Materials and Methods.
4. Section 23 0553: Mechanical Identification.
5. Section 23 2013: HVAC Piping.
6. Section 23 3000: Air Distribution.
7. Section 23 5000: Central Heating Equipment.
8. Section 23 8000: Heating, Ventilating and Air Conditioning Equipment.

1.02 REFERENCES

A. American Society for Testing and Materials International (ASTM):

1. ASTM C167 - Standard Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
2. ASTM C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation.

3. ASTM C411 - Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 4. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 5. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 6. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 7. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
 8. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 9. ASTM C739 - Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation.
 10. ASTM C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
 11. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 12. ASTM E795 - Standard Practices for Mounting Test Specimens During Sound Absorption Tests.
 13. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- B. Underwriters Laboratories Inc.:
1. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
 2. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
- C. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems .

2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
3. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 0500: Common Work Results for HVAC.
 1. Complete material list of items to be furnished and installed under this Section.
 2. Manufacturer's specifications and other data required demonstrating compliance with the specified requirements.
 3. Shop Drawings, catalog cuts and manufacturer's data indicating insulation, jacketing, adhesives, and coating. Insulating materials shall be certified by manufacturer to comply with the California quality standards for insulating materials.
 4. Display sample cutaway sections.
 5. Manufacturer's recommended method of installation procedures, which will become part of this Section.

1.04 QUALITY ASSURANCE

- A. Qualifications of Manufacturer and Installer, Materials, Fabrication, Execution, and Standard of Quality: Comply with provisions stated under Section 23 0500: Common Work Results for HVAC and Section 23 0513: Basic HVAC Materials and Methods.
- B. Test Ratings:
 1. Comply with provisions stated under Section 23 0500 and 23 0513 with emphasis on ASTM E84, NFPA 255, or UL 723. ASTM C167, ASTM C302, UL label or listing of satisfactory test results from the National Institute of Standards and Technology, or a satisfactory certified test report from an acceptable testing laboratory. Approval by the State Fire Marshal is required.
 2. Furnish labels, legibly printed with the name of the manufacturer or listings indicate that fire hazard ratings do not exceed those specified for materials proposed for installation. Flame spread index of not more than 25 and smoke developed rating not exceeding 50.

3. Tests shall be performed on each item individually when insulation, vapor barrier covering, wrapping materials, or adhesives are installed separately at the Project site.
 4. Test insulation, vapor barrier covering, wrapping materials and adhesives as an assembly when they are factory composite systems.
- C. Regulatory Requirements: Insulation furnished and installed under this Section shall conform to the requirements of the California Building Code Parts 4, Mechanical Code, Part 5, Plumbing Code and Part 6, Energy Code.
- D. All chemically based products such as sealers, primers, fillers, adhesives, etc. shall meet the California air quality regulations.

1.05 PRODUCT HANDLING

- A. Protection, Replacement, Delivery and Storage: Comply with provisions stated under Sections 23 0500: Common Work Results for HVAC and 23 0513: Basic HVAC Materials and Methods.

PART 2 – PRODUCTSMATERIALS

- A. General:
1. Piping insulating material shall be fire resistant, non-corrosive, shall not break, settle, sag, pack or disintegrate under vibration, nor absorb more than 1 percent moisture by weight.
 2. Piping insulating material shall be furnished with thickness indicated in Table 1, unless otherwise noted on the drawings, and shall furnish thermal resistance in the range of R-4.0 to 4.6 in accordance with inch at 75 degrees F. For any other value of R, insulation thickness shall be calculated accordingly and submitted for review.
 3. Asbestos in any quantity in insulating material is not permitted.
 4. Provide insulation materials, adhesives, coatings, sealants, fitting covers, and other accessories with a fire hazard rating not to exceed 25 for flame spread, 25 for fuel contributed and 50 for smoke developed, except for materials listed as follows:
 - a. Nylon anchors for installing insulation to ducts or equipment.
 - b. Treated wood blocks.
 5. Flame-proofing treatments subject to moisture damage are not permitted.

TABLE 1 - MINIMUM PIPING INSULATION THICKNESS (1)

Insulation Thickness Required (in inches)

Space Heating Systems (Steam, Steam Condensate and Hot Water)

Piping System Type	Temp. Range (degrees F)	Run-outs up to 2 (2)	1 and less	1.25 to 2	2.5 to 4	5 to 6	8 and larger
Hi Pres Temp	Above 350	1.5	2.5	2.5	3.0	3.5	3.5
Med Pres Temp	251 to 305	1.5	2.0	2.5	2.5	3.5	3.5
Low Pres Temp	201 to 250	1.0	1.5	1.5	2.0	2.0	3.5
Hot Water	Up to 200	0.5	1.5	1.5	1.5	1.5	1.5
Steam Cond.	-	0.5	1.0	1.0	1.0	1.5	1.5
Service Water Heating Systems (recirculating, piping supply and return)							
Hot Water	Up to 180	0.5	1.0	1.0	1.5	1.5	1.5
Space Cooling Systems (Chilled water, Brine and Refrigerant)							
Chilled Water	40-60	0.5	0.5	0.75	1.0	1.0	1.0
Refrigerant/Brine	Below 40	1.0	1.0	1.5	1.5	1.5	1.5
Condensate Drain	1/2 inch Minimum insulation thickness.	0.5	0.5	0.5	0.5	0.5	0.5
From Air Conditioning Equipment:	Insulate condensate drain lines within building, in room, inside walls and above ceilings.	0.5	0.5	0.5	0.5	0.5	0.5

NOTES: (1) For piping exposed to ambient temperatures, increase thickness by 0.5 inch.

(2) Run-outs to individual terminal units, not exceeding 12 feet in length.

- B. Lagging Adhesives: Shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Insulation finished with canvas shall be provided with laps adhered in accordance to manufacturer's recommendation. A finish coat of same material shall be applied to entire outer surface of lagging cloth at coverage specified by manufacturer.
- C. Canvas Jackets: Furnish 6 ounce in accordance with square foot minimum, 48 by 48 thread count canvas jacketing.
- D. Insulation Jackets:
 - 1. Exterior insulation exposed to weather shall be weatherproofed with Childers aluminum jacketing as basis of design, or Pabco, RPR, or equal. Jacketing shall be manufactured from 1100, 3105 or 5010 aluminum alloy with 3/16 inch corrugations. Smooth or embossed jackets may be permitted in special situations to match an existing installation. Jacketing shall be furnished with an integrally bonded moisture barrier over entire

surface in contact with insulation. A minimum thickness of 0.016 aluminum jacketing is to be provided on ducts and piping. A minimum thickness of 0.020 shall be provided on tanks, equipment, and heat exchangers.

2. Insulated elbows, of 90 degrees and 45 degrees, with a nominal iron pipe size of ½ inch to 8 inches shall be provided with Childers aluminum Ell-Jacs insulation covers as basis of design, or Pabco, RPR, or equal, manufactured from 1100 aluminum alloy of 0.024 inch thickness. Insulated elbows with a nominal pipe size of 10 inches to 18 inches shall be provided with Childers 4-piece aluminum Ell-Jacs as basis of design, or Pabco, RPR, or equal.
 3. Tees, Flanges, and Valve Insulation in Conjunction with Aluminum Jacketing: Furnish Childers Aluminum Special Fabrications Insulation Covers as manufactured by Childers Products Company, Pabco, RPR, or equal.
- E. Adhesives: Adhesives shall be water based, UL Classified, meet the requirements of NFPA 90A and NFPA 90B, have been tested according to relevant ASTM
- F. requirements, and be acceptable to the State Fire Marshal. Name, type and method of installation shall be submitted for review.
- G. Valve and Fitting Cover: When installed in conjunction with PVC jacketing, furnish Zeston 25/50 rated polyvinyl chloride fitting covers as manufactured by Johns Manville, Knauf Insulation, Speedline, or equal.

2.02 SPACE HEATING PIPING SYSTEM

- A. General: Insulate steam, steam condensate return, and hot water space heating supply and return, including valves, strainers and fittings with insulation thickness as indicated on Table 1.
- B. Materials:
1. Classes of Insulation:
 - a. Class A: Calcium silicate molded pipe insulation, suitable for service temperature up to 1200 degrees F, ASTM C533; Johns Manville Thermo-12 Gold, or equal. Fittings: diatomaceous silica thermal insulating cement.
 - b. Class B: Glass fiber molded pipe insulation suitable for service temperatures up to 850 degrees F. Pipe insulation shall be one piece, preformed, and provide a minimum R factor of 4.0 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire retardant vapor barrier jacket.
Pipe insulation shall be

Johns Manville Micro-Lok, Knauf Redi-Klad 1000, Owens Corning FIBERGLAS Pipe Insulation SSL II-ASJ, or equal.

- c. Class C: Flexible open-cell melamine (foam insulation) suitable for service temperature -150 degrees F to 400 degrees F. Thermal conductivity at 75 degrees F, $K = 0.26$. Pipe insulation, one-piece pre-formed, laminated to heavy non-reinforced PVC jacket, with locking track, factory installed to jacket, to snap insulation and jacket onto pipe. Similar to TechLite 079 Series as manufactured by Accessible Products Co., or equal. Installation shall comply with manufacturers recommendations.
- d. Class D: Mineral fiber pipe insulation suitable for service temperatures up to 1,200 degrees F. Pipe insulation shall be one-piece, preformed up to 3 inches thickness, and provide a minimum R factor of 4.0 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire-retardant vapor barrier jacket. Pipe insulation shall be 8 pounds in accordance with cubic foot density by Roxul Techton 1200, Fibrex COREPLUS 1200, Industrial Insulation Group, LLC (IIG) MinWool-1200, or equal.

2. Locations and Class of Insulation Required:

TABLE 2 – LOCATIONS AND CLASS OF INSULATION REQUIRED

<u>LOCATION</u>	<u>CLASS OF INSULATION</u>
Boiler and Mechanical Equipment Room	A, B, C, or D
All Other Locations	A, B, C, or D

- 3. Fittings on indoor piping shall be covered with flush, hand-wrapped Class A, B, C, or D insulation, to match the adjoining pipe insulation and covered with polyvinyl chloride fitting covers: Zeston 2000 25/50 by Johns Manville, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal.
- 4. Adhesive: Fibrous Adhesive to bond calcium silicate to itself and non-porous surfaces.

2.03 COOLING PIPING SYSTEM INSULATION

- A. General: Insulate chilled water supply and return piping and refrigerant piping.
- B. Materials:
 - 1. Classes of Insulation:
 - a. Class A: Expanded polystyrene pipe insulation, self-extinguishing type, either molded or extruded; Dow Chemical Co. STYROFOAM, ITW Insulation Systems XPS PIB, Foam-Control EPS, or equal.

- b. Class B: Glass fiber molded pipe insulation ASTM C547. Pipe insulation shall be one piece, preformed, and provide a minimum R factor of 4 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire retardant vapor barrier jacket. Pipe insulation shall be Johns Manville Micro-Lok, CertainTeed Snap-On, Owens Corning FIBERGLAS SSL II-ASJ, or equal.
 - c. Class C: Expanded (foamed) urethane (polyurethane) or polyisocyanurate pipe insulation of self-extinguishing type molded or fabricated, Dyplast Products, LLC ISO-C1/2.0, ITW Trymer, Specialty Products & Insulation Co. Polyisocyanurate Pipe Insulation, Armacell Armalok, or equal.
 - d. Class D: Foamed plastic pipe insulation, self-extinguishing type, ASTM C534 Type 1 - tubular. Pipe insulation shall be one-piece preformed, flexible tubing type and provide a maximum K factor of 0.28 at 75 degrees F mean temperature. Pipe insulation shall be Armacell Armaflex, Aeroflex Aerocel, Rubatex INSUL-TUBE 180, or equal.
2. Locations and Class of Insulation Required: For thickness required, refer to Table 1 of this Section.

TABLE 3 – SERVICE, LOCATION AND CLASS OF INSULATION REQUIRED

<u>SERVICE</u>	<u>LOCATION</u>	<u>CLASS OF INSULATION</u>
Condensate drains from air conditioning equipment	Indoors at all locations including above ceilings and between stud walls	D
Refrigerant suction Liquid line as required	All locations except underground	D
All other piping, except underground	All locations except underground	A, B, C

3. Adhesives:
- a. Polystyrene adhesives: Synthetic rubber and resin adhesives specifically designed to adhere extruded and expanded rigid polystyrene and urethane insulation to themselves and to other porous and non-porous substrates.
 - b. Vapor barrier laps and penetrations: Furnish protective coating and lagging adhesive on butt joints of foil-faced vapor barriers, and where pins and staples puncture facings.

2.04 HIGH TEMPERATURE EQUIPMENT INSULATION

- A. General:

1. Insulate heat exchangers, hot water storage tanks, flash tanks, boiler breechings, and similar equipment operating at elevated temperatures up to 450 degrees F or 850 degrees F with high temperature insulation, jacket and material.
2. Do not insulate condensate receivers, hot water expansion tanks, hot water pump casings, chemical feeders, and factory insulated boilers.

B. Materials:

1. Equipment insulation shall be 1-1/2 inches minimum fiberglass board or insulating blocks, or molded calcium silicate, ASTM C533-Type I, Johns Manville Thermo-12 Gold or 1000 Series Spin-Glas, Knauf Insulation Board, Owens Corning Fiberglas Series 700 or Fiberglas Insul-Quick, or equal.
2. Boiler breeching insulation shall be same as above except 2 inches thick minimum.
3. Adhesive: For calcium silicate, furnish fibrous adhesive of sodium silicate base.

2.05 LOW TEMPERATURE EQUIPMENT INSULATION

A. General:

1. Insulate water chillers, heat exchangers, air eliminators and similar equipment operating at reduced surface temperatures.
2. Do not insulate chilled water expansion tanks, and chemical feeders.

B. Materials:

1. Expanded polystyrene, 2 inches thick, self-extinguishing type, Dow Chemical Co.'s STYROFOAM, Owens Corning FOAMULAR, Foam-Control EPS, or equal, or 1-1/2 inches thick expanded urethane (polyurethane) or polyisocyanurate, self-extinguishing type, Dyplast Products, LLC ISO-C1/2.0, ITW Trymer, Specialty Products & Insulation Co. Polyisocyanurate Pipe Insulation, or equal.
2. Canvas Jackets: 6 ounce in accordance with square foot minimum.
3. Vapor Barrier Laps and Penetrations: Furnish protective coating and lagging adhesive on butt joints of foil-faced vapor barriers and where pins and staples puncture facings.

2.06 DUCTWORK AND PLENUM INSULATION

- A. General: Insulate ductwork and plenums with not less than the amount of insulation tabulated in Table 4, unless noted otherwise on the drawings. Insulation may be omitted under the following conditions:

1. Exposed return air ductwork in conditioned space.
2. Return air ductwork between wall studs inside an interior wall.

TABLE 4 - INSULATION OF DUCTS AND PLENUM

INSULATION TYPES

<u>Duct Location</u>	<u>Heating and Cooling</u>
Exposed interior supply ductwork	DW-1
On roof, and exterior of building	DW-2
In walls, within floor/ ceiling spaces	F-1
Hot and cold plenums	F-2 or DW-1
Attics, Garages, and Crawl Spaces, within unconditioned space or in basement	F-3

- B. Insulation Types:

1. DW-1: 1 inch thick insulation sandwiched inside double-wall type ducts and fittings. Duct joints shall be waterproofed.
2. DW-2: 2 inch thick insulation sandwiched inside double-wall type ducts and fittings. Duct joints shall be waterproofed.
3. F-1: 1 ½ inch blanket fiberglass, factory-laminated with all-service jacket vapor barrier.
4. F-2: 2 inch blanket fiberglass, factory-laminated with all-service jacket vapor barrier.
5. F-3: 3 inch blanket fiberglass, factory-laminated with all-service jacket vapor barrier.

- C. Notes:

1. Minimum insulation provided shall be as required by the current California Mechanical Code Title 24 for the most restrictive condition.
2. Refer to the materials indicated in this section for external insulation.
3. Insulation lining the duct interior is not permitted.

D. Materials:

1. Fire-Resistive Insulation Materials and Coatings: Submit State Fire Marshal pre-approved materials only.
2. Adhesives: See Paragraph 2.01.E for applicable products.
3. External Insulation: Provide glass fiber blankets that are factory-laminated with Foil Reinforced Kraft (FRK) vapor barrier facing; Johns Manville Microlite, Owens-Corning SOFTR Duct Wrap, Knauf Insulation Friendly Feel Duct Wrap, or equal. Provide a minimum installed R value as required by the CEC Building Energy Efficiency Standards; but not less than scheduled below:

TABLE 5
INSULATION OF DUCTS AND PLENUM INSTALLED
THERMAL RESISTANCE R VALUES

Type	Labeled Thickness (in inches)	Installed R Value (hr.ft ² .°F/Btu)
F-1	1 ½	4.2
F-2	2	5.6
F-3	3	8.3
DW-1	1	4.2
DW-2	2	5.6

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Except as specified herein, install material in accordance with recommendations of manufacturer. Do not install insulation materials until tests specified in other sections are completed. Remove foreign material such as rust, scale, or dirt. Surfaces shall be clean and dry. Maintain insulation clean and dry at all times.
- B. On cold surfaces where a vapor barrier must be provided and maintained, insulation shall be installed with a continuous, unbroken moisture and vapor seal. Hangers, supports, anchors, or other projections that are fastened to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- C. Surface finishes shall be extended in such a manner as to protect raw edges, ends, and surfaces of insulation.
- D. Pipe or duct insulation shall be continuous through walls, ceiling or floor openings, or sleeves; except where fire-stop or fire-safing materials are required.
- E. Metal shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed between the pipe and the

insulation shields. Inserts shall be of equal thickness to adjacent insulation and shall be vapor sealed accordingly.

F. Insulation shall not be installed in the following locations unless otherwise noted:

1. On vacuum return lines less than 50 feet long.
2. On unions, flanged connections or valve handles.
3. Over edges of any manhole, clean-out hole, clean-out plug, access door or opening to a fire damper, so as to restrict opening or identification of access.
4. Over any label or stamp indicating make, approval, rating, inspection, or similar data, unless provision is made for identification and access to label or stamp.

3.02 INSTALLATION OF HEATING PIPING SYSTEM INSULATION

A. General: Space heating hot water, domestic hot water, tempered water supply and return piping and condensate return piping, after having been tested, shall be cleaned and insulated.

B. Application: Insulate condensate return piping, hot water heating supply and return piping, steam and steam condensate piping, domestic hot water supply and return, including tempered supply and return piping in accordance with manufacturer's instructions and as specified herein.

1. Install insulation on valve bodies up to valve bonnet. Fill void in saddles, in accordance with Section 23 0513: Basic HVAC Materials and Methods, with insulation and seal joints.
2. Install insulating material to fittings, valves, and strainers and smooth to thickness of adjacent covering. Leave strainer clean-out plugs accessible. Covers fabricated from polyvinyl chloride shall be furnished.

C. Insulation Jackets in Exposed Indoor Locations:

1. Cover completed insulation with canvas jacket tightly pasted to covering with lagging adhesive. Lap jacket seams 1-1/2 inches minimum. Finish entire jacket with coating of undiluted adhesive.
2. Equivalent factory applied pre-sized, glass fiber reinforced, or glass fiber jackets may be furnished. Seal jacket seams with adhesive in accordance with manufacturer's instructions.

3. Johns Manville Zeston 2000, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal, fitting covers may be furnished, with molded or segmented insulation equal to specified insulation applied to fittings. Secure covers in accordance with manufacturer's instructions.
 4. In addition to above requirements, cover exposed insulated piping within a distance of 8 feet above floors with 26 gage galvanized steel jacket. Omit jacket in areas accessible only to maintenance personnel, such as mechanical equipment rooms, utility corridors, accessible pipe tunnels and manholes.
- D. Concealed Indoor Locations: Cover insulation over fittings, valves, and strainers with canvas. Provide pipe insulation with factory or field applied standard jacket of 4 ounce minimum canvas, fiberglass cloth, or glass fiber reinforced jacket. Seal jacket laps with adhesive in accordance with manufacturer's instructions.
- E. Exposed Outdoors: In addition to canvas or fiberglass cloth cover, pipe insulation exposed to weather shall be provided with an additional 0.016 inches thick aluminum jacket with 2 inches lap connected with one inch hem overlap joint located on side of pipe and turned down to shed water. Jacket shall be strapped 12 inches on center with 1/2 inches wide stainless steel strapping and wing seals. Aluminum jacket shall be mitered to fit fittings.

3.03 INSTALLATION OF COOLING PIPING SYSTEM INSULATION

- A. General: Chilled water supply and return piping, refrigerant piping and condensate drain lines, after having been tested, shall be cleaned and insulated.
- B. Application: Insulation on chilled water lines, refrigerant suction lines and liquid lines, if indicated, and air conditioner interior drain lines shall be jacketed with fire-resistant vapor barrier of laminated aluminum foil consisting of 2 plies with glass-yarn reinforcing. Jacket joints shall be lapped and sealed with an approved adhesive. Insulation shall be secured with aluminum bands not less than 0.005 inch thick by 3/4 inches wide, spaced not over 12 inches on centers, or as recommended by manufacturer.
1. Longitudinal Seams: Butt hinged sections of covering tightly together and seal down jacket flap with adhesive, or with factory-applied, self-sealing lap with pressure-sensitive sealer protected with release paper.
 2. End Joints: Wrap joint with a 3-inch wide (minimum) self-sealing tape.
 3. Fittings and Valves: Fittings and valves shall be covered with same material of same thickness as pipe insulation, sealed with an approved, vapor-sealing

tape or compound and covered with Johns Manville Zeston polyvinyl-chloride cover, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal.

4. Pipe hangers shall be insulated or attached to pipe by an insulating insert, butted between adjoining insulation sections.

C. Additional Jackets:

1. Exposed Indoor Insulation: Cover with 26 gage galvanized sheet metal jacket to 8 feet above floors, except in mechanical equipment rooms and accessible pipe tunnels.
2. Exposed Outdoor Insulation: In addition to canvas or fiberglass cloth cover, provide 0.016 inch thick aluminum jacket with one inch wide aluminum bands and seals. Install appropriate jackets on valves and fittings.

3.04 INSTALLATION OF HIGH TEMPERATURE EQUIPMENT INSULATION

- A. General: Provide insulation over parts of heat exchangers and similar equipment requiring insulation having removable head or sections.

B. Application:

1. Equipment: Securely tie insulation on with copper clad wire. Install tack coat weather barrier coating at a thickness specified by manufacturer. While tack coat is still wet, a layer of 10 open weave glass cloth membrane shall be embedded with fabric seams overlapped a minimum of 2 inches. Install a finish coat fully covering membrane at coverage rate specified by manufacturer.
2. Boiler Breechings: Wire securely V-rib wire lath, 3/4 inches minimum depth to boiler breechings, connections and stacks inside boiler rooms, and cover with insulation and jacket as specified above.
3. Manholes and Hand Holes: Maintain accessible by beveling off permanent insulation around manhole and cover manhole plate with removable blanket.

3.05 INSTALLATION OF LOW-TEMPERATURE EQUIPMENT INSULATION

- A. General: Provide removable sections of insulation over parts of chillers and similar equipment requiring insulation and having removable heads or sections.

- B. Exterior surfaces of chilled water system expansion tanks and chilled water pumps shall be insulated with not less than 2 inches thick expanded polystyrene or fiberglass, as specified. Fill spaces between insulation and equipment with granulated polystyrene or urethane to eliminate voids. Insulation shall be secured with metal band, and covered with one inch, 20 gage hexagon galvanized mesh and 1/4 inches thick insulating cement troweled smooth. Cement surface shall then be covered with 0.002 inches aluminum foil applied smoothly and secured with suitable adhesive, and a layer of 6-oz. canvas.

- C. Coat joints of polyurethane insulation with neoprene based contact adhesive. Adhesives furnished shall be approved by insulation manufacturer. Fill and seal external voids and seams with non-shrinking sealant.
- D. Canvas Jacket: Cover completed insulation with canvas jacket tightly pasted to covering with lagging adhesive. Lap jacket seams a minimum of 1 ½ inches. Finish entire surface of canvas jacket with one brush coat of diluted lagging adhesive, Childers CP-50A, Foster 30-36, Mon-Eco Industries (MEI) Eco-Lag Adhesive, or equal, and heavy final coat of undiluted adhesive.

3.06 INSTALLATION OF DUCTWORK AND PLENUM INSULATION

- A. External Covering:
 - 1. Before installing duct insulation, sheet metal ducts shall be clean, dry, and tightly sealed at joints and seams, inspected pressure tested, and accepted by LAUSD OAR/Inspector.
 - 2. Duct exterior insulation shall be firmly wrapped around ductwork with joints lapped a minimum of 2 inches. Insulation shall be securely fastened with 18 gage copper-lined steel wire, or 16 gage soft-annealed galvanized wire spaced approximately 12 inches on centers and at loose ends, presenting a neat and workmanlike appearance. Where duct width is such that wiring will not fasten insulation firmly against duct an adhesive shall be furnished to fasten insulation to duct with wiring being installed at ends of insulation segment.
 - 3. Insulation on ductwork transporting conditioned air, both supply and return, and outside air intake ducts when pre-conditioned, shall be furnished with a factory-applied, fire-resistant vapor barrier.
 - 4. Exposed Ducts or Plenum:
 - a. Install insulation to ducts or plenum furnished with butt joints, without voids and with adhesive over entire surface of duct. Cover insulation with canvas jacket, fastened tightly to insulation with lagging adhesive. Install 2 finish coats of undiluted adhesive.
 - b. When installing jacket, finished covering shall be even and level, without humps, with constant diameters on round ducts maintained.

3.07 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.08 PROTECTION

- A. Protect the Work of this Section until Substantial Completion.

END OF SECTION

SECTION 23 2013
ABOVE GROUND HVAC PIPING

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Above ground piping systems for heating, ventilating, and air conditioning systems. Systems include but are not limited to the following:
 - 1. Chilled Water System.
 - 2. Condenser Water.
 - 3. Hot Water Heating System.
 - 4. Low-pressure Steam.
 - 5. Miscellaneous Piping Required for Equipment of this Section.
 - 6. Connections to Exterior Utilities.
- B. Related Requirements:
 - 1. Division 01: General Requirements.
 - 2. Section 23 0500: Common Work Results for HVAC.
 - 3. Section 23 0513: Basic HVAC Materials and Methods.
 - 4. Section 23 0548: HVAC Sound, Vibration and Seismic Control.
 - 5. Section 23 0553: HVAC Identification.
 - 6. Section 23 0700: HVAC Insulation.
 - 7. Section 23 0900: HVAC Instrumentation and Controls.
 - 8. Section 23 2016: Underground HVAC Piping.
 - 9. Section 23 2500: HVAC Water Treatment.
 - 10. Section 23 6416: Oil Lubricated Centrifugal Water Chillers.
 - 11. Section 23 6418: Oil Free Centrifugal Water Chillers.
 - 12. Section 23 6423: Scroll Water Chillers.

13. Section 23 6426: Rotary-Screw Water Chillers.
14. Section 23 6428: Air-Cooled Rotary Screw Chillers.
15. Section 23 6500: Cooling Towers.
16. Section 31 2323: Excavation and Fill for Utilities.

1.02

REFERENCES

A. ASTM International:

1. ASTM A47 – Standard Specification for Ferritic Malleable Iron Castings.
2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
4. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
5. ASTM A181 - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
6. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
7. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.
8. ASTM B32 - Standard Specification for Solder Metal.
9. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
10. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

B. American National Standard Institute (ANSI) and The American Society for Mechanical Engineers (ASME):

1. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
2. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

3. ANSI/ASME B16.9 - Factory Made Wrought Butt-welding Fittings.
4. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

1.03 SUBMITTALS

- A. Provide submittals in accordance with Division 01, Sections 23 0500, Common Work Results for HVAC, and 23 0513, Basic HVAC Materials and Methods.
- B. Provide Shop Drawings with dimensioned piping layout and details of expansion loops, elbows, anchor points, pipe supports, building entry points and other pertinent information required to verify layout. Indicate systems, pipe material and sizes, show location of devices such as pumps, unions, joints, valves, flow measuring devices, fittings, flexible connectors, and location of hangers and supports, intent and type of materials are in accordance with this Section. Prefabricated pipe units shall be dimensioned and numbered to fit actual Work with field verified conditions prior to start of factory fabrication.
- C. Submit manufacturer's Product Data for products listed on Part 2 of this section, demonstrating conformance to specified standards and specification requirements.

1.04 QUALITY ASSURANCE

- A. Comply with applicable codes and referenced standards: ASTM, ASME/ANSI, CPC (California Plumbing Code), CMC (California Mechanical Code).
- B. Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Storage: Deliver materials to Project site in their original unopened containers with labels intact and legible at time of delivery. Store in strict accordance with manufacturer's recommendations.

1.06 COORDINATION

- A. Coordinate related and adjacent activities in accordance with Section 01 3113, Project Coordination.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Low Pressure Steam Systems:

1. Pipe: ASTM A53 Schedule 40 Type S-seamless Grade B black steel. Pipes and fittings shall be properly marked with schedule number, ASTM number, manufacturer, etcetera, in accordance with ASTM requirements.
2. Fittings:
 - a. 2-inch and smaller: 150 pound standard weight, black, malleable iron, threaded. Material conforms to ASTM A47; threads, ANSI/ASME B1.20.1 malleable iron, threaded.
 - b. 2 ½-inch and larger: Standard weight, seamless steel; welding fittings and flanges ASTM A234 and ANSI/ASME B16.9 for fittings and ASTM A181 or ASTM A105 for flanges.
3. Joints: Refer to Section 23 0513, Basic HVAC Materials and Methods, for threaded pipe joints and welded connections.
4. Unions on piping 2-inch Diameter and Smaller: 150 pound malleable iron, ground joint pattern, brass to iron seat, ASME B16.39 or ASTM A47, grade 32510, black.
5. Flanges on Piping 2 ½-inch Diameter and Larger:
 - a. 150 pound forged steel, weld neck or slip-on, ASTM A181 and ANSI/ASME B16.5. Furnish flat faced flanges against equipment with flat faced flanges.
 - b. Flange gaskets: Mineral fiber, 1/16 inch thick, equivalent to Garlock Style 9800, Durlon 8300, or equal.
 - c. Bolting materials: Carbon steel heavy hex bolts and nuts, ASTM A307, type B.

B. Chilled Water, Heating Hot Water and Condenser Water:

1. Pipe:
 - a. 2-inch and smaller: Standard weight, seamless copper, type L hard drawn, ASTM B88.
 - b. 2 ½-inches and larger: Schedule 40 seamless black steel, ASTM A53, grade B, type S. Pipes and fittings shall be properly marked

with schedule number, ASTM number, manufacturer, etcetera, in accordance with ASTM requirements.

2. Fittings:

- a. 2-inch and smaller: Wrought solder-type copper, in accordance with ANSI/ASME B16.22.
- b. 2 ½-inch and larger:
 - 1) 150 pound forged steel, weld neck or slip-on, ASTM A181 and ANSI/ASME B16.5. Furnish flat faced flanges against equipment with flat faced flanges.
 - 2) Flange gaskets: Mineral fiber, 1/16 inch thick, equivalent to Garlock Style 9800, Durlon 8300, or equal.
 - 3) Bolting materials: Carbon steel heavy hex bolts and nuts, ASTM A307, type B.

3. Joints:

- a. 2-inch and smaller: 95 percent tin and 5 percent antimony solder with non-acid flux type flux, ASTM B32, grade 95TA.
- b. 2 ½-inch and larger: Standard weight, seamless steel; welding fittings and flanges ASTM A234 and ANSI/ASME B16.9 for fittings and ASTM A181 or ASTM A105 for flanges.

4. Unions:

- a. 2-inch and smaller Wrought solder type, copper to copper; furnish ground joint cast bronze low lead unions, NIBCO 733, where copper connects to steel.
- b. 2 ½-inch and larger: Refer to Section 23 0513, Basic HVAC Materials and Methods, for threaded pipe joints and welded connections.

C. Valves: Chilled Water and Condenser Water.

- 1. Ball Valves, 2-inch and Smaller: Shall be 600 psi CWP, have cast brass bodies, replaceable reinforced Teflon seats, conventional port, blowout proof stems, chrome plated brass ball, and threaded or solder ends with extended solder cups.

Threaded

Solder

Stockham T-285-FB-R-70 (full port)	Stockham S-285-FB-R-70 (full port)
Crane 9301	Crane 9302
Worcester 44-11-RT-SE	Worcester 44-11-RT-TE
Jamesbury 351T	---
Apollo 70-100	Apollo 70-200
Equal	

2. Gate Valves, 2-inch and Smaller:

Class 125, body and bonnet ASTM B62. Cast bronze composition. Threaded or soldered ends. Solid disc, copper-silicon alloy stem, brass packing gland. Threaded ends: Stockham B-100 (RS) or B103 (NRS), Crane 428 or 438, Hammond IB640 (RS) or IB645 (NRS), or equal. Soldered ends: Stockham B104 (NRS) or B108 (RS), Milwaukee 115 (NRS) or 149 (RS), NIBCO S-113 (NRS) or S-111 (RS), or equal.

3. Gate Valves, 2 ½-inch and Larger:

Class 125 iron body, bronze mounted, ASTM A126, class B cast iron, flanged ends with Teflon impregnated packing and 2-piece packing glass.

OSY RS NRS

Stockham	G-623	G-612
Crane	465 1/2	461
Powell	1793	1787
Hammond	IR1140	IR 1138
Equal		

4. Butterfly Valves: 150 psi tight shut-off, ASTM A126.

a. Body: Lug type, ASTM A126 iron.

b. Disc:

1) For motorized valves: 304 Stainless Steel.

2) For Manual Valves: Cadmium-plated ductile, iron for chilled water (bronze, or aluminum bronze for condenser water).

c. Stem:

1) For motorized valves: 416 Stainless Steel.

2) For manual Valves: Solid one-piece, 304 or 316 or 410 stainless steel.

d. Seat and O-rings: EPDM O-ring.

- e. Upper and lower stem bearings: Bronze or reinforced Teflon.
- f. Operators:
 - 1) Valves 6-inch and smaller: Bray Series 21 as basis of design or Center Line, Stockham, Crane, Belimo, Nibco or equal, with lever handle, or Electric Actuator and disc position indicator.
 - 2) Valves 8-inch and larger: Bray Series 21 as basis of design or Center Line, Stockham, Crane, Belimo, Nibco or equal, manual gear operator and disc position indicator, or Electric Actuator.
- g. Manufacturers: Bray, Milwaukee, Center Line, Stockham, Crane, DeZURIK, Belimo, Nibco or equal.

5. Check Valves, 2-inch and Smaller:

Shall be of class 125, threaded or solder ends, body and caps shall be of ASTM B62 cast bronze composition, swing type disc.

<u>Threaded</u>	<u>Solder</u>
Stockham B-319Y	Stockham B-309Y
Hammond IB 904	Hammond IB 912
Crane 37	Crane 1707S
Powell 578	Powell 1825

Equal

- a) Class 150 valves meeting above Specifications may be furnished where pressure requires: Stockham B-321, NIBCO T-433-B, Milwaukee 515, or equal, threaded.

6. Check Valves, 2 ½-inch and Larger:

Shall be iron body, bronze mounted with body and cap conforming to ASTM A126, class B, cast iron, flanged ends, swing type disc.

Hammond	IR1124
Stockham	G-931
Crane	373
Powell	559
Equal	

7. Alternative Check Valves, 2 ½-inch and Larger:

Shall be class 125/250, iron body, bronze mounted, wafer check valves, with ends designed for flanged type connection, aluminum bronze disc, EPDM seats, 316 stainless steel torsion spring, and hinge pin.

Stockham WG-961
Center Line Series 800
Duo-Chek K12 HAP
Marlin M125 HZDSF
Equal

8. Non-Slam Check Valves (Pump Discharge):

Semi-steel body, bronze trim, top and bottom center guide, stainless steel spring and 125 pound flanged ends. Miller Manufacturing No. 162 or equivalent by Williams-Hager, Val-Matic Valve & Manufacturing Corp., or equal.

9. Air Vents: Spirotherm model Spirovent as basis of design or Amtrol, Watts, Dole, Bell and Gossett, or equal, manual type, of size for proper venting. Install at high points of systems.

D. Valves: Heating Hot Water, and Low-pressure Steam System.

1. Gate Valves, 2-inch and Smaller: Shall be of class 150 with body and union bonnet of ASTM B62 cast bronze composition, threaded or solder ends, solid disc, copper-silicon stem, brass packing gland, Teflon-impregnated packing, and malleable handwheel.

Threaded

Stockham B-120 (RS)
Hammond IB629
Crane 431UB
Powell 2714

Solder

Hammond IB648

Equal

2. Ball Valves, 2-inch and Smaller: Shall be 600 psi CWP, have cast brass bodies, replaceable reinforced Teflon seats, conventional port, blowout proof stems, chrome plated brass ball, and threaded or solder ends with extended solder cups.

Threaded

Stockham T-285-FB-R-70 (full port)
Crane 9301
Worcester 44-11-RT-SE
Jamesbury 351T
Apollo 70-100
Equal

Solder

Stockham S-285-FB-R-70 (full port)
Crane 9302
Worcester 44-11-RT-TE

Apollo 70-200

3. Gate Valves, 2 ½-inch and Larger: Shall be class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A126, class B, cast iron, flanged ends, with Teflon-impregnated packing and two-piece packing gland assembly.

	OS & Y	NRS
Stockham	G-623	G-612
Hammond	IR1140	IR1138
Crane	465 1/2	461
Powell	1793	1787
Equal		

4. Check Valves, 2-inch and Smaller: Shall be class 150 with body and cap of ASTM B62 bronze composition and threaded ends. Class 150 valves shall have lift-type non-metallic disc and union caps, and are to be furnished in lines with globe valves.

- a) For backflow prevention in lines with gate valves, Y-pattern valves with swing-type disc may be furnished.

Stockham B-322B
Crane 27TF
Equal

- b) For class 150 service, threaded ends:

Stockham B-321 Crane 137
NIBCO T-433-B
Equal

- c) For class 200 Service, threaded ends:

Hammond IB944 Crane 36
Stockham B-345 Powell 560
Equal

5. Check Valves, 2 ½-inch and Larger: Shall be iron body, bronze mounted, with body and cap conforming to ASTM A126, class B, cast iron, flanged ends, and swing-type disc.

Crane 373 Hammond IR1124
Powell 559 Stockham G-931
Equal

- a) Alternative for above listed check valves shall be class 125/250 iron body, bronze mounted, wafer check valve, with ends designed for flanged type connection, aluminum bronze disc, EPDM seats, 316 stainless steel torsion spring, and hinge pin.

Center Line Series 800 Hammond IR9253
Marlin M125 HZDSF Duo-Chek G12 HAP
Stockham WG-961 Equal

6. Automatic valves controlling steam to a coil in a hot water tank shall be single seated type. When these valves are installed on a gravity return system, they shall be two position type (i.e. completely open or completely closed).
 7. Valves on steam mains in boiler rooms shall be angle globe valves and be set to hold no condensate.
- E. Electric Motor Operated Valves: Belimo, Bray or equal.
- F. Valves, General:
1. Handles or hand wheels on valves shall be removable and, unless specified to be of loose key type, shall be securely fastened to their stems. Valve handwheels, except those on radiator valves, shall be of steel, brass, or cast iron.
 2. Boiler shut-off valves and valves on steam mains installed more than 6 feet above floor, shall be furnished with chain wheels and chains to within 6 feet of floor. Chains shall be free hanging and in a position to permit operation of valve from floor. When pulleys or extensions are required to locate these chains in such a position, furnish, and install said pulleys or extensions as required to provide a satisfactory operating installation. Extensions over one foot long shall be furnished with a supported outboard bearing.
 3. Furnish and install chains or wire rope with required accessories to open safety valves from boiler room floor.
 4. Radiator or convector valves shall be corner or angle type with composition handles, composition renewable discs, packing gland, union nut on tailpiece, unless otherwise specified. If exposed, they shall have a finished or plated exterior.
 5. Temperature Control Valves: Refer to Section 23 0513.
 6. Flow Control Valves: Refer to Section 23 0513.
- G. Flow Measuring Devices: Refer to Section 23 0513.
- H. Strainers: Refer to Section 23 0513.
- I. Condensate Drain Piping, from Air Handling Units: Refer to Section 22 0513.
- J. Indirect Drains, Relief Valve Discharge Piping and Air Vent Discharge Piping:
1. Pipe: Type L tempered copper water tube.

2. Fittings: Wrought copper. Refer to Section 23 0513. Furnish copper to threaded international pipe size adapters at threaded connections.
3. Joints:
 - a. Soldered: 95/5 solder.
- K. Insulation: Refer to Section 23 0700.
- L. Pipe Anchors, Pipe Guides, Expansion and Contraction Devices:
 1. Piping subject to expansion or contraction shall be fastened in a manner permitting strains to be evenly distributed and alleviated by swing joints or expansion loops or joints. Seismic restraints shall be installed so as not to interfere with expansion and contraction of piping.
 2. Provide anchors in heating or cooling piping system, to restrain and control direction of movement for expansion or contraction in piping system.
 3. Provide guides at specific locations in heating or cooling piping system in conjunction with slip or bellows type expansion joint.
 4. When coils or unit housings are shock or vibration isolated, provide piping flexible metal connector not less than 10 inches long whether they are indicated on the Drawings or not.
- M. Flexible Metal Connectors:
 1. Provide vibration elimination flexible metal connectors on chilled and hot water supply and return piping where rigidly supported pipes connects to unit housing coil attachments and units are supported by vibration isolators.
 2. Schedule Numbers:
 - a. FMC-1: Corrugated bronze metal hose with outer bronze braid in tubular sheath of woven metal wires. Connector with female copper tube ends for copper piping. Metraflex model BBS, Unisource Style UPCB-BRSW, Microflex, or equal.
 - b. FMC-2: Corrugated stainless steel metal hose with outer stainless steel braid in tubular sheath of woven metal wires. Connector with male pipe threads (NPT) for threaded piping. Metraflex model SST, Unisource Style UPCS-MMT, Microflex, or equal.
 - c. FMC-3: Corrugated Bronze Metal Hose with outer bronze braid in tubular sheath of woven metal wires. Connector with female copper

tubes ends for refrigeration piping. Metraflex model RAF, Unisource VIB, Anaconda Vibration Eliminators, or equal.

N. Refer to Sections 23 0513 for following:

1. Pipe Hangers and Supports.
2. Pipe Sleeves and Plates.
3. Pipe Flashings.
4. Relief Valves.
5. Thermometers.
6. Pressure Gages.
7. Pressure and Temperature Test Plugs.
8. Access Panels.
9. Dielectric Fittings.
10. Expansion Tanks.
11. Condensate Traps.

2.02 EQUIPMENT

A. Furnish centrifugal pumps capable of delivering rated capacity against total dynamic head as indicated on schedule and as specified for following:

1. Condenser Water Pump:

- a. Single stage base mounted, vertical split case, cast iron, bronze fitted construction. Pump impeller, casing bearings, capable of being serviced without disturbing piping connections.
- b. Impeller, enclosed type, hydraulically and dynamically balanced and keyed to shaft and secured with a suitable locknut.
- c. Pump shall employ a mechanical seal, with a carbon seal ring and ceramic (or tungsten carbide) seat. A shaft sleeve furnished under complete wetted area of mechanical seal.
- d. Bearing frame assembly of pumps fitted with oil lubricated bronze journal bearings and a hardened alloy steel shaft.

- e. Flexible coupling to absorb torsion vibration between pumps and motor.
- f. Motor: Resilient mounted, furnished with oil lubricated journal bearings.
- g. Pump: Factory tested, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. A set of installation instructions to be furnished with pump at time of shipment.
- h. Acceptable manufacturers: Taco, Armstrong, Paco, Bell and Gossett, Grundfos, Weinman, or equal.

2. Chilled Water Pumps:

- a. Horizontal, split case, fitted same as above, or end suction similar to that indicated below.
 - b. Frame mounted with flexible coupling on shaft.
 - c. Manufacturers: Taco, Armstrong, Paco Bell and Gossett, Weinman, or equal.
- 3. Hot Water Pumps: End suction, centrifugal, vertical split case, cast iron base mounted. Taco, Armstrong, Paco type L, Bell and Gossett, Grundfos, Weinman, or equal.
 - 4. Boiler Feed Pump: Two-stage, bronze fitted mechanical seals, double suction, regenerative turbine type with cast iron housing. Construction shall permit disassembly of pump without disturbing suction and discharge pipe connections. Pump impeller shall be bronze, mounted on stainless steel shaft supported by ball bearing on each side of pump casing. Pump shall be directly connected with a flexible coupling to an open drip-proof motor and mounted on a common steel base. Pump shall be operated from a boiler water level controller mounted on boiler. Pump shall be Roth Pump Co., Skidmore, Aurora, or equal. Pumps shall be electrically interlocked to 24-hour day/night operating boiler controls.

PART 3 – EXECUTION

3.01 PIPING INSTALLATION

- A. Install piping systems for chilled water, condenser water, and hot water and steam heating systems, condensate drains, and miscellaneous piping required for equipment, as indicated on Drawings and as specified in Section 23 0513.

- B. All piping and fittings size 2-1/2" and larger shall be welded – No Grooved type fitting is allowed except at chiller barrel and condenser barrel connections.

3.02 WATER PUMPS

- A. Install water pumps as indicated on Drawings and as specified unless otherwise noted. Provide vibration isolation and flexible pipe connections as specified in Sections 23 0548 and 23 0513.
- B. Floor mounted pumps shall be provided with a 4-inch high concrete base. For base, refer to Section 03 3000: Cast-In-Place Concrete.
- C. Provide leveling and alignment for base mounted pumps before and after installation.
- D. Provide suction diffuser for pumps where space constraints exist.
- E. Install pumps to allow complete removal without having to dismantle connecting pipes.
- F. Piping shall be supported from building structure to prevent any strain on pump casing. In-line pumps shall be separately supported from piping by furnishing pump manufacturer's specialized spring support kit, if available; pump shall not be rigidly supported.
- G. Flanged connections shall be provided on pumps with a discharge connection larger than 2 inches. Smaller sizes may be furnished with threaded connections. Except for special guided inlet fittings, inlets to suction side of pumps shall be a minimum of 10 diameters of straight pipe free from strainers, valves or fittings. On discharge side, minimum length of uninterrupted length of straight pipe shall be 5 diameters.
- H. Pumps, one horsepower or larger, shall be installed with required pump connections for noise and vibration isolation and not to compensate for misalignment.

3.03 AIR AND DIRT ELIMINATION

- A. Heating and chilled water piping and steam or hot water heating and/or cooling equipment shall be installed in a manner so that air will be eliminated from lines or equipment during operation. Pitch pipe lines as specified in Section 23 0513.
- B. Manual air valve shall be installed at each high point of chilled or hot water circulating lines, on each chilled water or hot water heating unit unless unit can vent through outlet connection. Refer to valves as specified under Section 23 0513.
- C. Air vent valves shall be installed with drains to nearest floor sink or outside building.

- D. Air/Dirt separators shall be installed on all hot water heating system, chilled water system, and closed loop fluid cooler system. Units shall be furnished with internal copper coalescing medium to facilitate maximum air and dirt separation and suppress turbulence. Units shall be furnished with galvanized steel strainer and stainless steel collector tube. Provide integral high capacity float actuated air vent at top fitting of tank. Furnish cast iron float actuated air vent rated at 150 psig, threaded to the top of the fitting. Unit shall be furnished with the bottom of the vessel extended for dirt separation with the system connection nozzles equidistant from the top and bottom of the vessel and shall include a blowdown connection and valve. Refer to Air/Dirt separators as specified under Section 23 0513.
- E. Acceptable manufacturers: Spirotherm, Bell and Gossett, Wessels, or equal.

3.04 CHEMICAL POT FEEDER

- A. Provide a chemical pot feeder in each of chilled water and hot water systems as specified in Section 23 2500: HVAC Water Treatment.

3.05 CONDENSER WATER TREATMENT

- A. Provide condenser water treatment as specified in Section 23 2500: HVAC Water Treatment.

3.06 CLEANUP

- A. Remove rubbish, debris and waste material and legally dispose of off the Project site.

3.07 PROTECTION

- A. Protect the Work of this Section until Substantial Completion.

END OF SECTION

SECTION 23 8000
HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Air conditioning and air handling equipment including but not limited to:
 - 1. Single Packaged Air Conditioning Units.
 - 2. Split System Air Conditioning Units.
 - 3. Split System Heat Pump Units.
 - 4. Fans.
- B. Related Requirements:
 - 1. Division 01: General Requirements.
 - 2. Section 07 6000: Flashing and Sheet Metal.
 - 3. Section 22 1000: Plumbing.
 - 4. Section 23 0500: Common Work Results for HVAC.
 - 5. Section 23 0513: Basic HVAC Materials and Methods.
 - 6. Section 23 0548: HVAC Sound, Vibration and Seismic Control.
 - 7. Section 23 0900: HVAC Instrumentation and Controls.
 - 8. Section 23 0923: Environmental Control and Energy Management System.
 - 9. Section 23 2013: HVAC Piping.
 - 10. Section 23 3000: Air Distribution.
 - 11. Section 23 5000: Central Heating Equipment.
 - 12. Section 23 6416: Oil Lubricated Centrifugal Water Chillers.
 - 13. Section 23 6418: Oil Free Centrifugal Water Chillers.
 - 14. Section 23 6423: Scroll Water Chillers.

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15. Section 23 6426: Rotary-Screw Water Chillers.

16. Section 23 6428: Air-Cooled Rotary Screw Chillers.

17. Section 23 6500: Cooling Towers.

1.02 DESIGN REQUIREMENTS

- A. Work of this Section is based on HVAC equipment units indicated as Basis of Design in Part 2 of this Section. Products from different HVAC equipment manufacturers listed are never identical, although equivalent in capacity, performance and quality. In the cases where dimensions, weight, configuration and utility requirements differ from the products used as a basis of design, the Contractor, at no additional cost to the Owner, shall coordinate and submit, for Architect review, revisions to the design.

1.03 SUBMITTALS

- A. Provide in accordance with Division 01 and Section 23 0500: Common Work Results for HVAC.
- B. For products listed that are not the basis of design, submit the following in addition to above requirements:
 - 1. Title 24 Calculations: Replace HVAC unit values in calculation files provided by the Architect and submit for review.

1.04 QUALITY ASSURANCE

- A. Provide submittals in accordance with Section 23 0500: Common Work Results for HVAC.

1.05 PROJECT RECORD DOCUMENTS

- A. Provide Owner instructions on equipment operation and maintenance procedures, as indicated in Section 23 0500: Common Work Results for HVAC.

1.06 WARRANTY

- A. Compressors shall be provided with manufacturer's five year warranty, replacement only.
- B. Manufacturer shall warrant parts, except heat exchangers, for a period of five years.
- C. Heat exchangers shall be provided with manufacturer's ten year warranty, replacement only.

PART 2 – PRODUCTS

2.01 EQUIPMENT

- A. Capacities of air conditioning equipment indicated on Drawings are net capacities actually required. Standard catalog ratings shall be adjusted to actual Project site environmental conditions.

2.02 AIR CONDITIONING UNITS - AC (2 Tons-25 Tons)

- A. Manufacturers: Carrier, Trane, York, Lennox, American Standard Heating & Air Conditioning, or equal.
 - 1. Basis of Design: [Carrier] [Trane] [York] [Lennox] [American Standard Heating & Air Conditioning]
- B. Furnish packaged air conditioning unit with gas heating for roof top installation. Unit shall be self-contained, completely factory assembled, with complete internal wiring and controls. Unit shall also be provided with a fully piped refrigerant circuit, fully charged with an environmentally friendly refrigerant that is not scheduled for phase out. Unit shall be field configurable for down-flow or horizontal discharge. Cooling and heating capacities, electrical characteristics, and operating conditions shall be as indicated on Drawings.
- C. Quality Assurance:
 - 1. Units shall be CSA certified for outdoor installation.
 - 2. Cooling capacity shall be rated in accordance with current ANSI/AHRI Standard 210/240.
 - 3. Unit shall be UL listed and designed to conform to ANSI/ASHRAE Standard 15 Safety Code for Mechanical Refrigeration and ANSI Z21.47-2016/CSA 2.3-2016 Gas
 - 4. ANSI/NFPA 70: National Electrical Code.
 - 5. Unit cooling efficiency EER/SEER ratings shall comply with CCR, Title 24, Building Energy Efficiency Standards for Residential and Nonresidential Buildings, and shall not be less than ratings indicated on drawings.
 - 6. Unit heating efficiencies AFUE ratings shall comply with current CCR, Title 24, Building Energy Efficiency Standards for Residential and Nonresidential Buildings, and shall not be less than ratings indicated on drawings.
 - 7. Unit shall comply with California Maximum Oxides of Nitrogen (NOX) Emission Regulations and current SCAQMD regulations.

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8. The unit roof curbs shall conform to NRCA standards.
9. Insulation and adhesive shall meet NFPA 90A and 90B requirements for flame spread and smoke generation.
10. Unit casing shall be capable of withstanding ASTM B117 500-hour salt spray test.
11. Each unit shall be run tested at factory per ANSI/ASHRAE 37 and provided with a certificate indicating tested pressures, amperages, dates, and inspector.

D. Unit Cabinet:

1. Galvanized steel with baked enamel finish on external surfaces that are exposed to weather.
2. Interior surfaces exposed to conditioned and return air streams shall be insulated with a minimum ½-inch thick, 1 pound density foil-faced cleanable insulation.
3. Cabinet top cover shall be of one piece construction or where seams exist, shall be double hemmed and gasket sealed.
4. Cabinet panels shall be hinged access panels for filter, compressors, evaporator fan, control box and heat section areas. Each panel shall use multiple quarter-turn latches. Each major external hinged access panel shall be permanently attached to rooftop unit. Panels shall also include tiebacks.
5. Return air filters shall be accessible through a hinged access panel and be on a slide-out track using standard size filters.
6. Holes shall be provided in base rails (minimum 16 gage) for rigging shackles and level travel and movement during overhead rigging operations.
7. Unit shall have a factory-installed internally sloped condensate drain pan, providing a minimum ¾-inch-14 NPT connection to prevent standing water from accumulating. Pan shall be fabricated of high impact polycarbonate material, epoxy powder coated steel or stainless steel and shall slide out for cleaning or maintenance. An alternate vertical drain (¾-inch NPT) connection shall also be available. Drain pans shall conform to ASHRAE 62 self-draining provisions.

E. Compressors:

1. Unit shall be furnished with single (If single compressor is used, then it shall be Two Stage type) or multiple fully hermetic scroll compressors with internal vibration isolators.
 2. Dual electrically and mechanically independent refrigerant circuits for 7.5 tons and above.
 3. Compressors shall be provided with service access valves.
 4. Compressor motors shall be cooled by refrigerant passing through motor windings.
 5. Compressors shall be provided with line break thermal and current overload protection.
 6. Compressors shall be provided with crankcase heaters, internal high-pressure and temperature protection.
 7. Compressors on unit rated 90,000 BTU and below shall be of two stage types.
- F. Refrigerant circuit components:
1. Thermostatic expansion valve (TXV) with removable power element.
 2. Refrigerant strainer.
 3. Service gage connections on suction, discharge, and liquid lines.
 4. Solid core refrigerant filter driers.
- G. Evaporator and Condenser Coils: Standard Evaporator and condenser coils shall be furnished with:
1. Acceptable Condenser Coils:
 - a. Copper-tube, Aluminum-fin coil, with liquid subcooler. Internally enhanced OD seamless copper tubing mechanically bonded to aluminum fins in combination with a factory applied Corrosion-Resistant Epoxy Coating. Provide Protective Hail Guard.
 - b. Spine Fin condenser coil shall be continuously wrapped, corrosion resistant aluminum with minimum brazed joints. This coil is 3/8 inch OD seamless aluminum tubing glued to a continuous aluminum fin. Coils are lab tested to withstand 2,000 pounds of pressure per square inch. The outdoor coil provides low airflow resistance and efficient heat transfer. The coil is protected on four sides by louvered panels.

- c. Coil shall be air-cooled Micro-Channel Heat Exchanger Technology (MCHX) and shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds. Coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for fins, tubes, and manifolds in combination with a factory applied Corrosion-Resistant Epoxy Coating. Provide protective Hail Guard.
- 2. Evaporator coils
 - a. Aluminum plate fins mechanically bonded to enhanced copper tubes with joints brazed.
 - b. Tube sheet openings shall be belled to prevent tube wear.
 - c. Evaporator coil shall be of full-face active design.
 - d. Dual circuit models shall have face-split type evaporator coil.
- H. Evaporator and Condenser Coils shall be furnished with copper plate fins mechanically bonded to enhanced copper tubes with copper tube sheets and brazed joints with a factory applied Corrosion-Resistant Epoxy Coating utilizing dipping process. Provide protective Hail Guard.
- I. Fans and Motors:
 - 1. Evaporator fan shall be a dynamically balanced, double width, double inlet, forward curved centrifugal type, fabricated of steel with a corrosion resistant finish that was tested and rated in accordance with AMCA requirements.
 - 2. Evaporator fans shall be direct-driven for the AC Units with the cooling capacity of less than or equal to 48,000 BTU/H, and belt or direct-driven for the AC units with the cooling capacity of greater than 48,000 BTU/H, as indicated on Drawings.
 - 3. Direct drive fans shall be provided with ECM motor.
 - 4. Evaporator blower and motor shall have permanently lubricated, factory-sealed ball bearings and automatic-reset thermal overload protection.
 - 5. Belt drive shall include an adjustable-pitch motor pulley. Belt drive fans shall accommodate from 0.6 inch to 1.6-inch external static pressure without changing drives or motors.
 - 6. Condenser fan shall be a dynamically balanced, propeller type, fabricated of aluminum blades riveted to corrosion resistant steel spiders and direct-driven by a totally enclosed motor. Condenser air shall be discharged

vertically. Condenser fan motor shall be high efficiency or ECM type motor and provide cooling operation down to 25 degrees F outdoor temperature with automatic-reset thermal overload protection.

J. Heating Section:

1. Induced draft combustion type with energy saving direct spark ignition system, redundant main gas valve, and 2-stage heat.
2. The heat exchanger shall be of tubular section type fabricated of a minimum of 20 gage steel coated with a nominal 1.2 mil aluminum-silicone alloy or 20 gage type 409 stainless steel, including stainless steel tubes, vestibule plate.
3. Burners shall be of in-shot type fabricated of aluminum coated steel or stainless steel.
4. Gas piping shall enter unit cabinet at a single location.
5. Integrated Controls shall provide following:
 - a. Timed control of evaporator fan functioning and burner ignition,
 - b. Anti-cycle protection for gas heat operation (after one cycle on high temperature limit switch and one cycle on flame rollout switch).
 - c. Diagnostic information.
6. Induced draft motor shall be provided with permanently lubricated, sealed bearings and inherent automatic reset thermal overload protection.

K. Controls, Safeties and Diagnostic Points:

1. Unit Controls: Unit shall be furnished with self-contained, network capable and ready direct digital controls.
 - a. Controls shall be factory-installed.
 - b. Controls shall operate with zone control systems.
 - c. Controls shall furnish built-in diagnostics for thermostat commands for staged heating and cooling, evaporator-fan operation, and economizer operation.
 - d. Controls shall be furnished with a 5-minute time delay between modes of operation.

- e. Control circuit shall be protected by a fuse on 24-V transformer side.
 - f. Control shall incorporate passive infrared detection for sensing occupancy in space serve.
2. Compressor high temperature, high current, internal overloads, internal thermostat.
- a. Compressor reverse rotation protection.
 - b. Loss-of-charge/low-pressure switch.
 - c. Freeze-protection thermostat, evaporator coil.
 - d. High-pressure switch. The lockout protection shall be easily disconnected at control board, if necessary.
 - e. Internal relief valve.
 - f. Anti-recycle relay, or time cycle device to prevent rapid cycling of compressor after any off cycle.
3. Heating section shall be provided with following minimum protections:
- a. High-temperature limit switches.
 - b. Induced draft motor speed sensor.
 - c. Flame rollout switch.
 - d. Flame proving controls.
 - e. Redundant main gas valve.
 - f. Heating controls shall consist of:
 - 1) 2-stage automatic combination gas valve.
 - 2) Pressure regulator.
 - 3) Electric spark intermittent ignition system or hot surface ignition system.
 - 4) Time delay fan control.
4. Operating Characteristics:

- a. Unit shall be capable of starting and operating at 125 degrees F ambient outdoor temperature, meeting maximum load criteria of AHRI Standard 210/240 or 360 at plus or minus 10 percent voltage.
 - b. Compressor with standard controls shall be capable of operation down to 25 degrees F ambient outdoor temperature.
- 5. EMS Diagnostic Points: Provide diagnostic points for units, including those at projects with no EMS.
 - a. Supply air temperature.
 - b. Return air temperature.
 - c. Space temperature.
 - d. Outdoor air temperature.
 - e. Filter status.
 - f. Fan status.
 - g. Compressor status.
 - h. Economizer damper current position.
 - i. Other diagnostic point required by current Title 24, automated fault detection and diagnostics (FDD).
- L. Filter Section:
 - 1. Provide filter section with factory-installed low-velocity, throwaway 2-inch thick high capacity, MERV 8 Class 2, or equal, filters of commercially available sizes unless noted otherwise on the drawings.
 - 2. Filter face velocity shall not exceed 300 fpm at nominal airflows.
 - 3. Filter section shall allow installation of standard size air filter.
 - 4. Return air filters shall be accessible through a hinged access panel using standard size filters.
- M. 100 Percent Outdoor Air Economizer:
 - 1. Provide 100 percent outdoor air economizers as indicated on drawings.
 - 2. Gear-driven integrated economizers.

3. Integrated integral-modulating type capable of simultaneous economizer and compressor operation.
4. Furnish hardware and controls to provide cooling with outdoor air.
5. Low-leakage dampers not to exceed 3 percent leakage, at one inch wg pressure differential (variable sliding economizer).
6. Barometric relief damper. Damper shall close upon unit shutoff.
7. Differential temperature and enthalpy controller unless indicated otherwise on drawings.
8. Provide units with centrifugal power exhaust controlled by a pressure sensor in space or outdoor air measurement and tracking as indicated on drawings. The controller shall modulate VFD in centrifugal power exhaust to maintain a pressure differential of 0.03 inch of water between indoor and atmospheric pressure. Furnish field wiring to power exhaust and install tubing in space. Provide other accessories as required to comply with UL or ETL requirements.
9. Base Rail: Factory installed on both horizontal and down-flow units.
10. Dampers Using Electronic Actuators:
 - a. Manufacturer: Belimo, Honeywell, Invensys, Johnson Controls, or equal.
 - b. Size for torque required for damper seal at load conditions.
 - c. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
 - d. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to prevent damage to the actuator during a stall condition.
 - e. Fail-Safe Operation: Mechanical, spring-return mechanism.
 - f. Power Requirements: Maximum of 10 VA at 24 VAC or 8 W at 24 VDC.
 - g. Proportional Actuators shall be fully programmable. Control input, position feedback and running time shall be factory or field programmable by use of external computer software. Diagnostic feedback shall provide indications of hunting or oscillation, mechanical overload and mechanical travel. Programming shall be through EEPROM without the use of actuator mounted switches.

- h. Actuators shall be listed by ISO 9001, ULC, and CSA C22.2.
- N. Furnish programmable digital thermostat with following features for single zone units that are not provided with variable volume and variable temperature type controls:
 - 1. 7-day time clock.
 - 2. Heat, cool, automatic changeover.
 - 3. Occupied/unoccupied modes.
 - 4. Dry contact switch for input from an external device such as a central time clock, occupancy sensor or a telephone activated device.
 - 5. Remote sensors. School Areas that could be subject to vandalism or accidental impact damage such as Gymnasiums, Auditoriums, Multipurpose Rooms, Corridors, and Lobbies shall be provided with thermostats with remote return air duct or room sensors. Verify remote location of sensors and thermostats with Architect.
 - 6. Robertshaw, Honeywell, Johnson Controls, Carrier, Schneider Electric, Viconics, or equal with built-in occupancy sensor. Refer to Section 23 0900 for areas with zone damper controls.
- O. Demand Controlled Ventilation:
 - 1. Units with 100 percent outdoor air economizers shall be provided with Indoor Air Quality (CO₂) Sensor and Accessory Electronic Expansion Boards.
 - 2. The unit shall have ability to provide demand ventilation indoor-air quality (IAQ) control through economizer when provided with an indoor air quality sensor and accessory expansion board.
 - 3. The IAQ sensor shall be wall mounted unless otherwise indicated on Drawings. The set point shall be adjustable.
 - 4. The IAQ sensor shall be powered through unit. If not, required control transformer shall be provided by manufacturer. Coordinate power requirements and location with Division 26.
 - 5. The IAQ sensor shall provide a 0-10 VDC signal to expansion board.
- P. Parts Availability: Submit proof in writing that majority (minimum 80 percent) of the replacements parts are commonly available and not proprietary. Also, submit proof in writing that a local parts sales and service facility exists, where replacement parts will be warehoused in quantity. Guarantee timely availability for parts that are proprietary.

2.03. COOLING ONLY FAN COIL UNITS AND CONDENSING UNITS

- A. Manufacturer: Carrier, Trane, York, Lennox, American Standard Heating & Air Conditioning, or equal.
 - 1. Basis of Design: [Carrier] [Trane] [York] [Lennox] [American Standard Heating & Air Conditioning]
- B. FCU and CU: Furnish fan coil unit (FCU) and condensing unit (CU), split type, air-cooled, roof or ground for ducted connections or free blow. Units shall be air-cooled condensing unit/direct expansion fan coil combinations. Condensing unit outdoor section shall be factory assembled with a direct-drive condenser fans with horizontal or vertical air discharge, scroll-type compressor, refrigerant coil, fan motors, pre-wired control panel and a holding charge of a non-ozone depleting refrigerant. Contractor shall provide additional refrigerant for extended lines. Indoor fan coil unit shall be furnished with horizontal discharge and will include evaporator coil, fan and motor, condensate pan with drain, thermal expansion valve, pre-wired control panel and remote thermostat control. Unit shall provide an EER/SEER complying with CCR, Title 24, Building Energy Efficiency Standards for Residential and Nonresidential Buildings. UL listed and rated at AHRI Standard 210/240.
- C. Nominal unit cooling, heating capacities, electrical characteristics, and operating conditions shall be as indicated on Drawings.
- D. Condenser coils:
 - 1. Acceptable Condenser Coils:
 - a. Copper-tube, aluminum-fin coil, with liquid subcooler. Internally enhanced 3/8-inch outside diameter, seamless copper tubing mechanically bonded to aluminum fins with a factory applied Corrosion-Resistant Epoxy Coating. Provide Protective Hail Guard.
 - b. Spine Fin™ condenser coil shall be continuously wrapped, corrosion resistant aluminum with minimum brazed joints. This coil is 3/8 inch outside diameter seamless aluminum tubing glued to a continuous aluminum fin. Coils are lab tested to withstand 2,000 pounds of pressure per square inch. The outdoor coil provides low airflow resistance and efficient heat transfer. The coil is protected on four sides by louvered panels.
 - c. Coil shall be air-cooled Micro-Channel heat exchanger technology (MCHX) and shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds. Coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for fins, tubes, and manifolds in combination with a factory

applied Corrosion-Resistant Epoxy Coating. Provide Protective Hail Guard.

- E. Condenser Coils shall be furnished with copper plate fins mechanically bonded to enhanced copper tubes with copper tube sheets and brazed joints. Coated coils are not acceptable.
- F. Evaporator coils:
 - 1. Aluminum plate fins mechanically bonded to enhanced copper tubes with joints brazed.
 - 2. Tube sheet openings shall be belled to prevent tube wear.
 - 3. Evaporator coil shall be of full-face active design. Dual circuit models shall have face-split type evaporator coil.
- G. Evaporator Coils at locations within two miles from ocean shall be furnished with copper plate fins mechanically bonded to enhanced copper tubes with copper tube sheets and brazed joints. Coated coils are not acceptable.
- H. Condenser Fan and Motors: Condenser fan shall be a dynamically balanced, propeller type, fabricated of aluminum blades riveted to corrosion resistant steel spiders and direct-driven by a totally enclosed motor. Condenser air shall be discharged horizontally or vertically. Condenser fan motors shall be high efficiency or ECM type motor.
- I. Cabinets: Fabricated of galvanized steel, bonderized and finished with baked enamel.
- J. Compressor shall be serviceable two stage or variable speed type hermetic scroll. Compressor shall be furnished with access valves and shall be installed on rubber isolators to reduce sound vibration. It shall be furnished with high and low-pressure protection. Each horizontal discharge condensing unit shall be furnished with a factory installed suction accumulator. Field installed accumulators are not permitted. It shall be furnished with high and low-pressure protection, brass external vapor supply line service valves, vapor return line service valves with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps, filter drier, pressure relief, liquid line solenoid valves, thermostatic expansion valves, and a holding charge of refrigerant.
- K. Controls: Compressor motor assembly shall be protected with high and low-pressure switches, internal overloads, internal thermostat, internal relief valve, and anti-recycle relay, or time cycle device to prevent rapid cycling of compressor after any off cycle. Unit shall incorporate an automatic relay for indoor circulating air blower. Control panel shall be pre-wired in unit casing. The control circuit shall incorporate a manual reset safety circuit to render refrigerant system (compressor and outdoor air motor) inoperative should there be a loss of airflow or

refrigerant. Units shall also be furnished with automatic condenser-fan motor protection, high condensing temperature protection, compressor motor current and temperature overload protection, high pressure relief, and condenser fan failure protection.

L. EMS Diagnostic Points:

1. Supply air temperature.
2. Return air temperature.
3. Space temperature.
4. Filter status.
5. Fan status.
6. Compressor status.
7. Other diagnostic point required by current Title 24, automated fault detection and diagnostics (FDD).

M. Low Ambient Operation: Head pressure control shall be provided for operation at outside air temperature below 45 degrees F.

N. Filters: Filters shall be 2-inch standard size high capacity replaceable media type MERV 8, or equal, installed in an external 2-inch rack filter section and complete with an access door.

O. An in-line filter-drier shall be provided with equipment and shall be installed at Project site.

P. Economizer: Provide on units with capacities equal to, or larger than 4.5 tons nominal capacity, when the Prescriptive Compliance approach is utilized to comply with Energy Efficiency Standards or where necessary to achieve CHPS pre-requisite and/or CHPS building flush-out compliance. Economizer shall be manufacturer's standard; factory furnished and field installed. Economizer control shall maintain a fixed supply air temperature during free cooling operation by providing full modulation of operable outside and return air dampers.

2.04. HEAT PUMP AND FAN COIL UNITS

A. Manufacturer: Carrier, Trane, York, Lennox, American Standard Heating & Air Conditioning, or equal.

1. Basis of Design: [Carrier] [Trane] [York] [Lennox] [American Standard Heating & Air Conditioning]

- B. HP and matching indoor fan coil unit and condenser unit: Furnish heat pump, split type, air-cooled, roof or ground installation with ducted connections or free blow. Units shall be air-cooled heat pump/direct expansion fan coil combinations. Heat pump outdoor section shall be factory assembled and furnished with direct-drive condenser fans with horizontal or vertical air discharge, scroll type compressor, refrigerant coil, fan motors, pre-wired control panel. Unit shall also be provided with a fully piped refrigerant circuit, fully charged with an environmentally friendly refrigerant that is not scheduled for phase out. Provide additional refrigerant for extended lines. Indoor fan coil unit shall be furnished with horizontal discharge and will include evaporator coil, fan and motor, condensate pan with drain, thermal expansion valve, pre-wired control panel and remote thermostat control. Nominal unit cooling, heating capacities, electrical characteristics, and operating conditions shall be as indicated on Drawings.
- C. Quality Assurance:
1. Cooling capacity rated in accordance with current AHRI Standard 210/240 and 270. Units shall be listed in AHRI.
 2. Unit construction shall comply with ANSI/ASHRAE 15, latest revision, and with NEC.
 3. Units shall be constructed in accordance with UL standards and shall carry UL label of approval. Units shall have CSA approval.
 4. Units shall be listed in CEC directory.
 5. Unit cabinet shall be capable of withstanding ASTM B117 500 hour salt spray test.
 6. Unit shall provide an EER/SEER/COP complying with CCR, Title 24, Building Energy Efficiency Standards and per the drawings.
- D. Evaporator and condenser coils: Evaporator and condenser coils shall be copper with mechanically bonded, smooth aluminum plate fins. Tube joints shall be brazed with copper or silver alloy. Coils shall be pressure-tested at factory. Protective metal guard for inlet and outlet of outdoor coil.
- E. Evaporator and Condenser Coils at locations within two miles from ocean shall be furnished with copper plate fins mechanically bonded to enhanced copper tubes with copper tube sheets and brazed joints. Coated coils are not acceptable.
- F. Fans:
1. Condenser Fan and Motors: Condenser fan shall be ECM type motor direct driven, propeller type arranged for horizontal or vertical discharge. Condenser fan motors shall be furnished with inherent protection, and shall be permanently lubricated type, resiliently mounted for quiet operation. Each fan shall be furnished with a safety guard.

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2. Evaporator fan section shall be furnished with ECM type motor centrifugal, forward curved, double width, double inlet fan or fans installed on a solid shaft. Fan shall be statically and dynamically balanced and shall rotate on permanently lubricated bearings.
- G. Unit Cabinets:
1. Cabinets shall be fabricated of galvanized steel, bonderized and finished with baked enamel.
 2. Cabinet interior shall be insulated with minimum one inch thick foil face fiberglass.
 3. Outdoor unit compartment shall be isolated and have an acoustic lining to assure quiet operation.
- H. Compressor: Compressor shall be two stage or variable speed type hermetic scroll.
1. Compressor shall be furnished with access valves and it shall be installed on rubber isolators to reduce sound vibration.
 2. Furnish with high and low-pressure protection.
 3. Each heat pump shall be furnished with factory installed suction accumulator. Field installed accumulators are not permitted.
 4. It shall be furnished with high and low-pressure protection, brass external vapor supply line service valves, vapor return line service valves with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps, filter drier, pressure relief, liquid line solenoid valves, thermostatic expansion valves, and a holding charge of refrigerant.
- I. Refrigeration Components: Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader type fittings with brass caps, accumulator, bi-flow filter drier, pressure relief, reversing valve, heating mode metering device, and a holding charge of refrigerant.
- J. Controls and Safeties:
1. Compressor motor assembly shall be protected with high and low-pressure switches, internal overloads, internal thermostat, internal relief valve, and anti-recycle relay, or time cycle device to prevent rapid cycling of compressor after any off cycle.
 2. Control panel shall be pre-wired in unit casing.

3. The control circuit shall incorporate a safety circuit to render refrigerant system (compressor and outdoor air motor) inoperative should there be a loss of airflow or refrigerant.
 4. Units shall also be furnished with automatic condenser-fan motor protection, high condensing temperature protection, compressor motor current and temperature overload protection, high pressure relief and condenser fan failure protection.
- K. EMS Diagnostic Points:
1. Supply air temperature.
 2. Return air temperature.
 3. Space temperature.
 4. Filter status.
 5. Fan status.
 6. Compressor status.
 7. Other diagnostic point required by current Title 24, automated fault detection and diagnostics (FDD).
- L. Low Ambient Operation: Head pressure control shall be provided for operation at outside air temperature below 45 degrees F.
- M. Safeties:
1. High condensing temperature protection.
 2. Compressor motor current and temperature overload protection.
 3. High pressure relief.
 4. Outdoor fan failure protection.
- N. Filters:
1. Filters shall be 2-inch standard size high capacity replaceable media type, MERV 8, or equal, installed in an external 2-inch rack filter section and complete with an access door.
 2. An-line filter-drier shall be furnished with equipment and installed at Project site.

- O. Economizer: Provide on units with capacities equal to, or larger than 4.5 tons nominal capacity, when the Prescriptive Compliance approach is utilized to comply with Energy Efficiency Standards or where necessary to achieve CHPS pre-requisite and/or CHPS building flush-out compliance. Economizer shall be manufacturer's standard; factory furnished and field installed. Economizer control shall maintain a fixed supply air temperature during free cooling operation by providing full modulation of operable outside and return air dampers.
- P. Provide programmable digital thermostat with following features:
1. 7-day time clock.
 2. Heat, cool, automatic changeover.
 3. Occupied / Unoccupied modes.
 4. Dry contact switch for input from an external device such as a central time clock, occupancy sensor, or a telephone activated device.
 5. Robertshaw, Honeywell, Johnson Controls, Carrier, Schneider Electric, Viconics, or equal with built-in occupancy sensor. Refer to Section 23 0900 for areas with zone damper controls.
 6. Remote sensors. School Areas that could be subject to vandalism or accidental impact damage such as Gymnasiums, Auditoriums, Multipurpose Rooms, Corridors and Lobbies shall be provided with thermostats with remote return air duct or room sensors. Verify remote location of sensors and thermostats with Architect.
- Q. P. Demand Control Ventilation:
1. Units of 6.25 nominal tons and higher capacity shall be provided with Indoor Air Quality (CO2) Sensor and Accessory Electronic Expansion Boards.
 2. The unit shall have ability to provide demand ventilation indoor-air quality (IAQ) control through economizer when provided with an indoor air quality sensor and accessory expansion board.
 3. The IAQ sensor shall be duct mounted in return air main duct unless otherwise indicated on Drawings. The set point shall be adjustable.
 4. The IAQ sensor shall be powered through unit. If not, required control transformer shall be provided by manufacturer. Coordinate power requirements and location with Division 26.
 5. The IAQ sensor shall provide a 4 to 20 mA signal to expansion board.

- R. Start-up: Factory test each unit before shipment to Project site. Performance test shall include full refrigeration start-up, fan and controls start-up. Each unit shall be provided with its own report with its own serial number. Non-tested units are not permitted to be delivered to Project site. Provide full start-up of units to include full refrigeration and provide a written report.
- S. Parts Availability: Submit proof in writing that majority (minimum 80 percent) of replacements parts are commonly available and not proprietary. Also, submit proof in writing that a local parts sales and service facility exists, where replacement parts will be warehoused in quantity. Guarantee timely availability for parts that are proprietary.

2.05 ROOF MOUNTED POWER EXHAUST VENTILATORS

A. RMEV-1

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VEBK Series	GB Series	ACEB	Domex-Belt Drive	BCRD	

2. Spun aluminum, roof mounted, belt driven, downblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Provide required accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories Inc (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. A two piece top cap shall have stainless steel, or galvanized quick release latches to provide access into motor compartment without use of tools, or screws. An integral conduit chase shall be provided through curb cap and into motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 16 gage steel power assembly, isolated from unit structure with rubber vibration isolators. These components shall be enclosed

in a weather-tight compartment, separated from exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate.

5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
7. Bearings: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
8. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision-machined cast iron type, or heavy gauge galvanized steel, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

B. RMEV-2:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VEDK Series	G Series	ACED	Domex-Direct Drive	DCRD	

2. Spun aluminum, roof mounted, direct driven, downblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.

3. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. An integral conduit chase shall be provided through curb cap and into motor compartment to facilitate wiring connections. The motor shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Unit shall bear an engraved aluminum nameplate.
5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed bearings and furnished at specified voltage, phase, and enclosure.

C. RMEV-3:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VUBK Series	CUBE Series	ACRUB	Fumex-Belt Drive	BCRU	

2. Spun aluminum, roof mounted, belt driven, upblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum

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structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. A two piece top cap shall have stainless steel, or galvanized quick release latches to provide access into motor compartment without use of tools, or screws. An integral conduit chase shall be provided into motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 16 gage steel power assembly, isolated from unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate.

5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
7. Bearing: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
8. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron, or galvanized steel type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

D. RMEV-4:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VUDK Series	CUE Series	ACRUD	Fumex-Direct Drive	DCR U	

2. Spun aluminum, roof mounted, direct driven, upblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes,

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performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.

3. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. An integral conduit chase shall be provided into motor compartment to facilitate wiring connections. The motor shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Unit shall bear an engraved aluminum nameplate.
5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed bearings and furnished at specified voltage, phase, and enclosure.

2.06 INLINE FANS

A. ILF-1: (Used as Garage Exhaust Fan GEF-1)

1. Manufacturer:

GREENHECK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
QEI or QEID	ESI	QSL	

2. Provide inline mixed flow type fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper

operation and balancing of fans in accordance with design intent and sequence of operation.

3. Certification: Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear AMCA certified ratings seal for sound and air performance.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The housing shall be of minimum 12 gage steel. Bearing supports shall be minimum 10 gage welded steel. Lifting eyes shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate.
5. Finish: Steel fan components shall be coated with polyester powder coating to exceed 1,000 hour salt spray test under ASTM B117 test method.
6. Wheel: Wheel shall be of mixed flow type with a wheel cone, spherical back plate and single thickness cambered blades, or formed hollow airfoil blades continuously welded to back plate. Hub shall be keyed and securely attached to fan shaft. Wheel shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
7. Motor: Motor shall be ECM type, voltage and phase, as indicated on drawings. Provide permanently lubricated sealed ball bearings. Option: Energy efficient motor meets EPA Act and NEMA Table 12-10.
8. Shaft: Blower shaft shall be AISI C1045/SAE 1045, or 1040 hot rolled and accurately turned, ground, and polished. Shafting shall be sized for a critical speed of at least 143 percent of maximum RPM.
9. Bearings: Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball or roller type in a cast iron pillow block housing and selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
10. Drive: Fans shall be direct drive or belt driven as indicated on drawings.
11. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The

variable pitch motor drive must be factory set to specified fan RPM.

2.07 CEILING CABINET FANS

A. CCF-1:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VCDK or VCDD Series	SP or CSP Series	GC 200 or 900 Series	Zephyr Fans	T or TL Series	

2. Provide ceiling, wall, or inline mounted, direct driven, centrifugal exhaust fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories (UL 507 & 705). Fan shall bear AMCA Certified Ratings Seal for Sound and Air Performance.
4. Housing: The fan housing shall be minimum 22 gage galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 16 gage reinforcing channel and shall be easily removable from housing. Motor shall be mounted on vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A powder painted white steel grille shall be provided as standard.
5. Wheel: Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be ECM type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall be furnished at specified voltage.

B. CCF-2:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VCDK or VCDD Series	CSP Series	GN 200 or 900 Series	Zephyr Fans	TL Series	

2. Provide inline mounted, direct driven, centrifugal exhaust fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories (UL 507 & 705). Fan shall bear AMCA Certified Ratings Seal for Sound and Air Performance.
4. Housing: The fan housing shall be minimum 22 gage galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 16 gage reinforcing channel and shall be easily removable from housing. Motor shall be mounted on vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different mounting positions, an adjustable pre-punched mounting bracket shall be provided.
5. Wheel: Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be ECM type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall be furnished at specified voltage.

C. CCF-3:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
	K				

VDBA or VGBA Series	BCF Series	DB	Zephyr Cabinet Fans	DBS or DBT	

2. Provide duct mounted, belt driven centrifugal cabinet fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 22 gage galvanized steel with two access doors and integral duct collars. Internal blower and motor assembly shall be mounted on rubber vibration isolators. Hanging brackets shall be provided for horizontal installation. Unit shall bear an engraved aluminum nameplate.
5. Wheel: Wheel shall be DWDI centrifugal forward curved type, constructed of painted steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy duty TEFC inverter duty type with permanently lubricated sealed ball bearings and furnished at specified voltage and phase.
7. Bearing: Bearings shall be permanently lubricated, sealed ball type selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
8. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

2.08 GRAVITY EXHAUST/INTAKE VENTILATORS

A. GEIV-1:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL

GSAA Series	GRS Series	PR or TR	WCC	GRV	

2. Spun aluminum, roof mounted gravity ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation of ventilators per code and in accordance with design intent and sequence of operation.
3. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The spun aluminum baffle shall have a rolled bead for added strength. Birdscreen constructed of 1/2" mesh shall be mounted across air opening. Unit shall bear an engraved aluminum nameplate.
4. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01" static pressure.
5. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper.

B. GEIV-2:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
GEAB Series	FGR Series	GR	AEG Relief	MGR	

2. Provide hooded aluminum, roof mounted gravity relief ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation and balancing of ventilators in accordance with design intent and sequence of operation.
3. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The hood interlocking panels shall be constructed of minimum 12 gage Aluminum 5052, hinged to a minimum 12 gage aluminum 5052 support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. Birdscreen

constructed of ½ inch mesh shall be mounted across relief opening. Unit shall bear an engraved aluminum nameplate.

4. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01 inch static pressure.
5. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper.

C. GEIV-3:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
GIAB Series	FGI Series	GI	AEG Intake	MGI	

2. Provide hooded aluminum, roof mounted gravity intake ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation and balancing of ventilators in accordance with design intent and sequence of operation.
3. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The hood interlocking panels shall be constructed of minimum 18 gage Aluminum, bolted to a minimum 12 gage aluminum 5052 support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. Birdscreen constructed of ½ inch mesh shall be mounted across intake opening. Unit shall bear an engraved aluminum nameplate. Units shall be provided with bird screen and anti-condensate coating as standard.
4. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01 inch static pressure.
5. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper.

2.09 FUME HOOD EXHAUST

A. FHE-1:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VBBB Series	SWB Series	CPV	Dynamo	BCV	

2. Fume Hood Exhaust: Provide single width, single inlet, backward inclined aluminum wheel, belt driven centrifugal vent sets of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
 - a. Provide the existing fume hood with airflow measuring device indicating the rate of inward airflow as a quantitative airflow monitor that continuously indicates whether air is flowing into the exhaust system during operation.
3. Certification: Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear AMCA Certified Ratings Seal for Sound and Air Performance and be manufactured with Type C spark resistant construction.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper shall be minimum 14 gage steel with scroll drain and scroll side panels shall be minimum 14 gage steel. The entire fan housing shall have continuously welded seams for leakproof operation. A performance cut-off shall be furnished to prevent recirculation of air in fan housing. The fan housing shall be field rotatable to any one of eight discharge positions and shall have a minimum 1 ½-inch outlet discharge flange. Bearing support shall be minimum 10 gage welded steel. Side access inspection ports shall be provided with quick release latches for access to motor compartment without removing weather cover. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate.
5. Finish: Exterior steel fan components shall be an electrostatically applied, baked epoxy powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2.5 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method. Interior and exterior parts of the fan exposed to the air being moved shall be coated with minimum 15 mils of baked epoxy.
6. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast

aluminum hub. Wheel hub shall be keyed and securely attached to fan shaft. Wheel inlet shall overlap a one piece aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.

7. Motor: Motor shall be heavy-duty, explosion proof type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
8. Shaft: Blower shaft shall be AISI C1045/SAE 1045 hot rolled and accurately turned, ground, and polished. Shafting shall be sized for a critical speed of at least 143 percent of maximum RPM.
9. Bearing: Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
10. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

B. FHE-2:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VBBB Series	SWB Series	CPS	Dynamo	BCV	

2. Provide single width, single inlet, backward inclined steel wheel, belt driven centrifugal vent sets of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
 - a. Provide the existing fume hood with airflow measuring device indicating the rate of inward airflow as a quantitative airflow monitor that continuously indicates whether air is flowing into the exhaust system during operation.

3. Certification: Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear AMCA Certified Ratings Seal for Sound, Air Performance and be manufactured with Type C spark resistant construction.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper shall be a minimum 14 gage steel with scroll drain and scroll side panels shall be a minimum 12 gage steel. The entire fan housing shall have continuously welded seams for leak proof operation. A performance cut-off shall be furnished to prevent re-circulation of air in fan housing. The fan housing shall be field rotatable to any one of eight discharge positions and shall have a minimum 1 ½-inch outlet discharge flange. Bearing support shall be minimum 10 gage welded steel. Side access inspection ports shall be provided with quick release latches for access to motor compartment without removing weather cover. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate.
5. Finish: Steel fan components shall be an electrostatically applied, baked epoxy powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2.5 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method. Interior and exterior parts of the fan exposed to the air being moved shall be coated with minimum 15 mils of baked epoxy.
6. Wheel: Wheel shall be steel centrifugal backward inclined, non-overloading flat blade type. Blades shall be continuously welded to backplate and deep spun inlet shroud. Wheel hub shall be keyed and securely attached to fan shaft. Wheel inlet shall overlap a one piece aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
7. Motor: Motor shall be heavy-duty, explosion proof type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
8. Bearing: Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty re-greasable anti friction ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

9. Shaft: Blower shaft shall be AISI C1045/SAE 1045 hot rolled steel and accurately turned, ground, and polished. Shafting shall be sized for a critical speed of at least 143 percent of maximum RPM.
10. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

2.10 FILTERS

- A. Air filters shall be of pleated, high capacity, disposable type of efficiencies indicated on drawings. Each filter shall consist of a non-woven cotton fabric media, media support grid, and enclosing frame. Filter shall be UL 900 listed, Class 2.
- B. Filter media shall provide an average efficiency as specified on drawings per ASHRAE Standard 52.2.
- C. Initial resistance of air filters shall not exceed following limits for each efficiency level at face velocities indicated. Lower resistance requirements, if indicated on drawings shall have precedence.

30 percent (MERV 8)	0.27 inch water gage at 500 feet per minute
75 percent (MERV 11)	0.28 inch water gage at 500 feet per minute
85 percent (MERV 13)	0.30 inch water gage at 500 feet per minute
95 percent (MERV 14)	0.38 inch water gage at 500 feet per minute
- D. Use standard size Filter Medias only.
- E. Media support shall be a welded wire grid or a rigid frame with an effective open area of not less than 96 percent.
 1. Media support shall be bonded to filter media to eliminate possibility of media oscillation and media pull-away.
 2. Media support grid shall be formed in such a manner that it effectively forms a radial pleat design, providing total use of filter media.
- F. Enclosing frame shall be bonded to air entering and air exit side of each pleat, to ensure pleat stability. Inside periphery of enclosing frame shall be bonded to filter pack, thus eliminating possibility of air bypass.
- G. Holding frames shall be factory fabricated of 16 gage galvanized steel, or equivalent and shall be furnished with gaskets and spring type positive sealing fasteners. Fasteners shall be capable of being attached or removed without use of tools.

- H. Manufacturers: Camfil Farr, Koch, or AAF.
- 2.11 LOUVERS, AIR CONDITIONING (use in conjunction with relief damper)
 - A. Standard steel louvers shall be furnished complete with frames, blades, finish and construction details per Drawings and manufacturer's recommendations.
 - B. Louvers shall be furnished with horizontal blades, 2 inches deep for air through wall installation in conjunction with gravity relief damper for backdraft protection that will open at 0.01 inch wc room static pressure as indicated on Drawings. Blades shall be 16-gage steel, spaced at 1 7/8-inch at 30 degrees angle, and with baked epoxy coating. Panel size shall be as indicated but not less than 24 inches width by 18 inches in height.

PART 3 – EXECUTION

3.01 GENERAL

- A. Examine areas under which Work of this Section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

3.02 EQUIPMENT FOUNDATIONS

- A. Provide foundations (housekeeping pads, level platforms or curbs) for mechanical equipment whether indicated on drawings or not. Equipment foundations shall be of sufficient size and weight, and of proper design to preclude shifting of equipment under operating conditions, or under abnormal conditions imposed upon equipment.
- B. Provide foundations (housekeeping pads, level platforms or curbs) for mechanical equipment whether indicated on drawings or not. Foundations shall meet requirements of equipment manufacturer and, when required by Architect, obtain from equipment manufacturer, approval of foundation design and construction, for equipment to be installed. Equipment vibration shall be maintained within design limits, and shall be dampened and isolated. Isolators shall be bolted to a structural member so as to be readily removable.

3.03 EQUIPMENT DESIGN AND INSTALLATION

- A. Uniformity: Unless otherwise specified, equipment of same type or classification shall be product of same manufacturer.
- B. Application: Only provide equipment as reviewed by Architect.
- C. Equipment Installation: Equipment installation shall be in strict accordance with these Specifications, and installation instructions of manufacturers. Equipment installed on concrete foundations shall be grouted before piping is installed.

Piping shall be installed in such a manner as not to place a strain on equipment. Flanged joints shall be adequately extended before installation. Piping shall be graded, anchored, guided and supported, without low pockets.

1. Install equipment in a neat and skillful manner, properly aligned, leveled, and adjusted for satisfactory operation.
2. Install so connecting and disconnecting of piping and accessories can be readily accomplished, parts are readily accessible for inspection, service and repair. Space shall be provided to readily remove filters, coils, compressors and fan wheels. Access doors shall be hinged with cam lock door handles.
3. Provide flexible connections for duct, pipe and conduit connections at moving equipment.

3.04 ROOF-TOP EQUIPMENT MOUNTING

- A. Downflow Packaged Units: Install unit on a prefabricated mounting frame or curb secured directly to roof. Follow manufacturers recommended installation manuals. Submit Shop Drawings for review by Architect.
- B. Horizontal Flow Packaged Units: Install unit on platform or prefabricated mounting frame or curb secured directly to roof designed to suit roof conditions and requirements of provided unit. Submit Shop Drawings for review by Architect.

3.05 NOISE AND VIBRATION

- A. Operation of Equipment: Mechanical equipment and piping systems shall operate without exceeding specified noise and/or vibration levels.
- B. Corrective Measures: If specified noise and/or vibration levels are exceeded, provide necessary changes to reduce noise and/or vibration levels to within specified levels.

3.06 FIELD TESTS AND INSPECTION

- A. General: Perform field inspections, field tests, and trial operations as specified in Section 23 0500: Common Work Results for HVAC. Provide labor, equipment and incidentals required for testing. The Project Inspector will witness field tests and trial operations as specified in Section 23 0500: Common Work Results for HVAC.
- B. Equipment and Material: Equipment and material certified as being successfully tested by manufacturer, in accordance with referenced Specifications and standards, will not require re-testing before installation. Equipment and materials not tested at place of manufacture will be tested before or after installation, as applicable or necessary, to determine compliance with reference Specifications and standards.

- C. Start-Up and Operational Test: System shall be started up and initially operated with components operating. During this test, various strainers or filters shall be periodically cleaned until no further accumulation of foreign material occurs. Adjust safety and automatic control instruments as required to provide proper operation and control sequence. Refer to Section 23 0500: Common Work Results for HVAC.
- D. Extent of Field Tests: After installation and before completion, Work of this Section shall be subjected to required field tests, including those specified here and in Section 23 0500: Common Work Results for HVAC.
- E. Operation and Maintenance Data: Provide required operation and maintenance data as specified in Section 23 0500: Common Work Results for HVAC.

3.07 REFRIGERANT PIPING

- A. Unless otherwise indicated, main liquid and suction lines from condensing unit to evaporator coil shall be of sizes specified by manufacturer.
- B. Refrigeration piping shall be refrigeration grade copper tubing, type L hard-drawn. In instances where refrigeration lines are installed in an inaccessible location and must be snaked through conduit or a trench, that portion of tubing required to complete connections through conduit or trench may be soft drawn. Maintain entire system clean and dry during installation. Pipe shall be sealed until installed.
- C. Refrigeration piping, both hard and soft-drawn, shall be straight and free from kinks, restrictions and horizontal runs shall be sloped towards compressor one inch to 10 feet wherever possible. Vapor line oil traps shall be installed on bottom of vertical risers and inverted oil trap shall be installed on top of vertical risers.
- D. Joints shall be installed with Sil-Fos 15, Silvaloy 15, or equal.
- E. Flare nuts required on suction lines shall be of short forged or frost-proof type. Other fittings shall be standard sweat-soldered type. Ells and return bends shall be long radius type. Install leak lock material.
- F. Refrigeration Piping: Joints shall be silver brazed and leak tested. Field fabricated lines shall be thoroughly flushed and cleaned before connection. Bleed nitrogen through lines during silver brazing, and cap and seal lines when not completed and connected to equipment.
- G. Sleeve penetrations of floors, walls and ceiling to allow for free motion of piping. Provide 24 gage galvanized iron pipe and chrome-plated escutcheon plates. Pack annular space between pipe and sleeve with incombustible material such as fiberglass and seal each end with mastic to provide a waterproof seal.
- H. Install insulated couplings at points of connection between dissimilar metals for cathodic protection. Insulate copper tubing from ferrous materials and hangers

with 2-inch thickness of 3-inch wide strip, 10 mil polyvinyl tape wrapped around pipe.

- I. Support piping by iron hangers and supports. Hydra-Zorb cushion clamps, LSP Products Group Acousto Clamp, or equal, on non-insulated piping, and Klo-Shure coupling clamp on insulated piping, or equal.
- J. Provide saddles to protect pipe insulation.
- K. Provide connections of copper, copper plated steel, steel, and brass pipe and tubing with Harris Products Group Safety-Silv 56, Lucas-Milhaupt, Inc., or equal, complying with ANSI/AWS A5.8 and NSF 51.
- L. Insulate refrigerant suction lines.
- M. On split heat pump systems, insulate both vapor and liquid lines. For insulation materials, refer to Section 23 0700: HVAC Insulation.

3.08 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off Project site.

3.09 PROTECTION

- A. Protect Work of this Section until Substantial Completion.

END OF SECTION

SECTION 26 0526
GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Provide and install grounding system as indicated or required.

1.02 QUALITY ASSURANCE

- A. Reference Standards:

1. IEEE 142 Green Book.
2. Underwriter's Laboratories (UL).
3. California Electrical Code.
5. EIA/TIA (Signal and power).
6. Nationally Recognized Testing Laboratory (NRTL) or equal.

1.03 SYSTEM DESCRIPTION

- A. Metallic objects on the Project site that enclose electrical conductors, or that are likely to be energized by electrical currents, shall be effectively grounded.
- B. Metal equipment parts, such as enclosures, raceways, and equipment grounding conductors, and earth grounding electrodes shall be solidly joined together into a continuous electrically conductive system.
- C. Metallic systems shall be effectively bonded to the main grounding electrode system.
- D. A separately derived AC source shall be grounded to the equipment grounding conductor, and to separate "made" electrode of building grounding electrode system.
- E. Electrical continuity to ground metal raceways and enclosures, isolated from equipment ground by installation of non-metallic conduit or fittings, shall be provided by a green insulated grounding conductor of required size within each raceway connected to isolated metallic raceways, or enclosures at each end. Each flexible conduit over six feet in length shall be provided with a green insulated grounding conductor of required size.

- F. Cold water, or other utility piping systems, shall not be utilized as grounding electrodes due to the installation of insulating couplings and non-metallic pipe in such installations. In addition to bonding to cold water pipe provide at least one of the following made grounding electrodes:
1. A dedicated "made" electrode, fabricated of at least 20 feet of galvanized 1/2 inch diameter rebar encased by at least two inches of concrete, and placed next to the bottom of a concrete foundation, or footing in direct contact with earth. A welded extended portion shall surface at the location of the common grounding electrode bus bar and be extended by a 3/0 CAD welded bare copper cable, or be CAD welded directly to the bus. The CAD weld shall be at least four inches above finished floor in a dry location. The main grounding electrode and associated grounding conductors shall be in an enclosure and in conduit.
 2. Grounding electrodes as specified hereafter in this section.
 3. Concrete enclosed electrode, fabricated of at least 20 feet of No. 2 AWG, minimum size, bare copper conductor, encased by at least two inches of concrete, located within or near bottom of a concrete foundation, or footing, which is in direct contact with earth. Footing rebar shall be connected to copper wire with approved connectors. An external electrode, as specified hereafter or as required by the CEC, shall be installed and connected to foundation or footing rebar.
- G. Non-current carrying metal parts of high-voltage equipment enclosures, signal and power conduits, switchboard and panelboard enclosures, motor frames, equipment cabinets, and metal frames of buildings shall be permanently and effectively grounded. Provide a CEC sized grounding conductor in every raceway.
- H. Metallic or semi-conducting shields and lead sheaths of cables operating at high voltage, shall be permanently and effectively grounded at each splice and termination.
- I. Neutral of service conductors shall be grounded as follows:
1. Neutral shall be grounded at only one point within the Project site for that particular service. Preferable location of grounding point shall be at the service switchboard, or main switch.
 2. Equipment and conduit grounding conductors shall be bonded to that grounding point.
 3. If other buildings or structures on the Project site are served from a switchboard or panelboard in another building, power supply is classified as a feeder and not as a service.
 4. Equipment grounding conductor is installed from switchboard to each individual building. At building, grounding conductor is bonded with

power equipment enclosures, metal frames of building, etc., to “made” electrode for that building.

- 5. Feeder neutrals shall be bonded at service entrance point only, neutrals of separately derived systems shall be bonded at the source only.
 - J. If there is a distribution transformer at a building the secondary neutral conductor shall be grounded to “made” electrode serving the building.
 - K. Within every building, the main switchboard or panelboard, shall be bonded to the cold water line. Metallic piping systems such as gas, fire sprinkler, or other systems shall be bonded to the cold water line.
- 1.04 SUBMITTALS
- A. Provide in accordance with Division 01.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Furnished yard boxes shall be precast concrete and shall be approximately 14 inches wide by 19 inches long by 12 inches deep or larger, if necessary to obtain required clearances. Boxes shall be furnished with bolt-down, checkered, cast iron covers and cast iron frames cast into boxes. Yard boxes shall be Jensen Precast, Oldcastle Precast, Western Precast, Kistner , or equal.
- B. “Made” electrodes shall be copper-clad steel ground rods, minimum 3/4 inch diameter by ten feet long.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Grounding electrodes shall be installed in the nearest suitable planting area, where not otherwise indicated on Drawings, and each electrode shall terminate within a concrete yard box installed flush with finish grade. In planting areas, finish elevation of concrete yard boxes shall be two inches above planting surfaces.
- B. If concrete enclosed electrode is provided, grounding wire shall be terminated to a suitable copper plate with grounding lugs and must be enclosed in a raceway or box..
- C. Grounding rods shall be driven to a depth of not less than eight feet. Permanent ground enhancement material, (GEM) as manufactured by Erico Electrical

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Products, Loresco Powerset, Tessco Ultrafil or equal, shall be installed at each ground rod to improve grounding effectiveness. Install in accordance with manufacture's installation instructions.

- D. Grounding electrodes shall provide a resistance to ground of not more than 25 ohms.
- E. When installing grounding rods, if resistance to ground exceeds 25 ohms, two or more rods connected in parallel, or coupled together shall be provided to meet grounding resistance requirements.
- F. Ground rods shall be separated from one another by not less than ten feet.
- G. Parallel grounding rods shall be connected together with recognized fittings and grounding conductors in galvanized rigid steel conduit, buried not less than 12 inches below finish grade.

3.02 TESTING

- A. Provide the services of an approved independent testing laboratory to test grounding resistance of "made" electrodes, ground rods, bonding of building steel, water pipes, gas pipes and other utility piping. Tests shall be performed as follows:
 - 1. Visually and mechanically examine ground system connections for completeness and adequacy.
 - 2. Perform fall of potential tests on each ground rod or ground electrode where suitable locations are available per IEEE Standard No. 81, Section 8.2.1.2. Where suitable locations are not available, measurements will be referenced to a known dead earth or reference ground.
 - 3. Perform the two point method test per IEEE No. 81, Section 8.2.1.1 to determine ground resistance between ground rod and building steel, and utility piping - such as water, gas and panelboard grounds. Metal railings at building entrances and at handicapped ramps shall also be tested.
 - 4. Test shall be performed in the presence of the Inspector.
- B. Submit 3 copies of test results to the Architect. Test results shall be submitted on an official form from the independent testing laboratory recording Project location, test engineer, test conditions, test equipment data, ground system layout or diagram, and final test results.

3.03 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.04 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 26 0533
RACEWAYS, BOXES, FITTINGS, AND SUPPORTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Raceways and wire ways.
 - 2. Conduit installation.
 - 3. Underground requirements.
- B. Applicable Standards and Codes.
 - 1. EIA/TIA 569 Standards.
 - 2. National American Standards Institute (ANSI).
 - 3. National Electrical Manufacturer's Association (NEMA).
 - 4. Nationally Recognized Testing Laboratory (NRTL).
 - 5. California Electrical Code (CEC).
 - 6. Uniform Building Code (UBC).
 - 7. Underwriters Laboratory (UL).

1.02 SUBMITTALS

- A. Materials List: Provide in accordance with Division 01.

PART 2 - PRODUCTS

2.01 RACEWAYS

- A. Conduit Materials:
 - 1. Metallic conduit, and tubing shall be manufactured under the supervision of an UL, or another NRTL factory inspection and label service program. Each ten-foot length of conduit and tubing shall bear the UL or another NRTL label and manufacturer's name.
 - 2. Rigid metallic conduit shall be rigid steel, heavy wall, mild steel, zinc-coated, with an inside and outside protective coating manufactured in accordance with ANSI C 80.1. Couplings, elbows, bends, conduits, bushings and other fittings shall be the same materials and finish as the rigid metallic conduit. Fittings, connectors, and couplings shall be threaded type, manufactured in accordance with ANSI C 80.1 and UL 6.

3. Electrical metallic tubing shall be steel tubing, zinc-coated with a protective enamel coating inside, manufactured in accordance with NEMA C 80.3. Fittings, couplings, and connectors shall be gland compression type, set screw couplings and connectors not permitted. All parts shall be manufactured in accordance with NEMA C80.3 and UL 6A Electrical metallic tubing is designated hereinafter as EMT. Steel and rain tight fittings shall be approved and listed for the intended application.
 4. Flexible steel conduit shall be of flexible interlocking strip construction with continuous zinc coating on strips, manufactured in accordance with UL 1.
 - a. Connectors and couplings shall be required fittings of the type, which threads into convolutions of flexible conduit.
 5. Liquid-tight flexible metal conduit shall be galvanized heavy wall, flexible locked steel strip construction, UV rated, with smooth moisture and oil-proof, abrasion-resistant, extruded plastic jacket. Connectors shall be as required for installation with liquid-tight flexible conduit and shall be installed to provide a liquid-tight connection.
 6. Non-metallic conduit shall be rigid PVC electrical conduit extruded to schedule 40 dimensions of Type II. Grade 1 high impact, polyvinyl chloride, sweeps, couplings, reducers and terminating fittings shall be listed under the UL, or another NRTL, and shall bear the manufacturer's listed marking.
 7. Multi-cell raceway shall be four inch PVC, Type 40, UL or another NRTL listed for underground use with optical fiber and signal system cables. Raceway shall be furnished with 3-1/2 inch factory installed inner ducts with required internal spacers, and required couplers, sweeps, and end bells. Multicell raceway shall be Carlon Multigard, or District approved equal.
 8. Metal Clad (MC) cable system is not allowed.
- B. Sleeves for Conduits: Sleeves shall be adjustable type by Carlon, U.S. Plastic, PEP Plastic or equal.
- C. Where conduit enters a building through a concrete foundation below grade, or ground water level, or where it is necessary to seal around a conduit where it passes through a concrete floor or wall, provide O-Z/Gedney Type FSK Thru Wall and Floor Seal, equivalent Cooper Crouse Hinds Thru-Wall, Legrand Thru-Wall, or equal.
- D. Expansion Joints-Seismic Separations between building(s) and other locations as indicated on drawings:
1. Provide Thomas & Betts XJG-TB, O-Z/Gedney. type AX with bonding strap and clamps, Cooper XJGD or equal. At exterior locations, provide Thomas & Betts XJG-TB, O-Z/Gedney type EX, Cooper XJGD, or equal. Provide O-Z/Gedney type AXDX, or equal combination deflection/expansion fittings at

all seismic separations. Provide manufacture's internal and external bonding jumpers at all locations. Liquid-tight metal conduit or flexible

metal conduit shall not be approved at expansion joints, separations between buildings or seismic separations.

2. Provide expansion fittings at intervals not exceeding 100 feet in conduits exposed to direct sunlight. Fittings may be installed in the conduit run or where conduit attaches to junction or pull boxes. OZ/Gedney type AX, TX or EXE series, or equivalent by Thomas and Betts, Crouse-Hinds or approved equal.

E. Conduit Seal Fittings:

1. Provide conduit seal fittings where indicated on the Drawings. Conduit seals shall be of rigid galvanized steel. Seals in horizontal conduit installations shall be Thomas & Betts EYS, Appleton Type ESU, Crouse Hinds Type EYS, or equal. Seals in vertical conduit installations shall be Thomas & Betts EYD, Appleton Type SF, Crouse Hinds Type EYD, or equal, with continuous drain. When installing conduit seals make provision for percent fill space reduction in accordance with CEC.
2. Install sealing compound after wire has been installed. Ensure drain is not blocked in vertical seals when installing compound. Where conduit seals are installed in hazardous area applications, there shall be no conduit coupling, fitting, etc., between seal and boundary of hazardous area.

F. Surface Steel Raceway:

1. The surface steel raceway system for branch circuit wiring, data network, voice, video, and other low voltage wiring shall be as manufactured by the Wiremold Company, Hubbell, or Mono-Systems, Inc. or equal. The raceway system may be supplied pre-wired in accordance with all sections of these specifications and requirements herein, and shall be UL or another NRTL listed. Computer data installation shall be as required by other sections of this Division.
 - a. If furnished pre-wired, the system must be listed in accordance with UL or another NRTL for "Multiple Outlet Assemblies" and so labeled on interior of the assembly. The pre-wired installation must contain no extra wire splices in the raceway as compared to a contractor assembled installation assembled from components. The pre-wired steel raceway shall be Hi-Pot tested at the factory to prevent any potential bare wire or shot circuit defects.

2. The raceway base, cover, and device bracket shall be manufactured of steel and finished in ivory, gray enamel or custom colors suitable for field painting to match adjacent finishes.
3. The raceway shall be a two-piece design with a metal base and snap-on metal cover, except for the Wiremold V700 system, Hubbell HBL750 series and Mono-Systems Inc. S145-700 series that shall be a one-piece design. The base and cover sections shall be a minimum of 0.040 inch wall

thickness. The base section shall be available in ten-foot lengths. A hand-operated cutting tool shall be available for the base and cover to ensure clean, square cuts. Wiremold V500, Hubbell V500, and Mono Systems inc. SM500 series are not permitted.

4. A full complement of fittings shall be furnished, including but not limited to, flat internal and external elbows, tees, entrance fittings, wire clips, cover clips, couplings, support clips, C-hangers and end caps. The fitting color shall match the raceway color. Fittings shall be supplied with a base where indicated and/or required. A take-off fitting shall be furnished as required to adapt to existing flush wall boxes.
 5. Device brackets shall be furnished for mounting single or two-gang devices within the raceway. Devices shall be provided with the ability of mounting flush or in conjunction with standard steel, stainless steel, or manufacturer's metal faceplates.
 6. The raceway shall be furnished with a complete line of connectivity outlets and modular inserts for unshielded twisted pair including category 5, fiber-optic, coaxial, and other cabling types with face plates and bezels to facilitate installation. Computer data installation shall be as required by other sections of this Division, and Division 27.
 7. Raceway shall be furnished with corner elbows and tee fittings to maintain a cable bend radius which meets the requirements of fiber-optic and copper cables under EIA/TIA 569 for communications pathways.
- H. Wireways shall be 16 gage galvanized steel enclosed hinge/screw wiring troughs, surface metal raceway, wireway, and auxiliary gutter designed to enclose electrical wiring. Wireway fittings shall be furnished with removable covers and sides to permit complete installation of conductors throughout the entire wireway run. Cover shall be furnished with keyhole slots to accept captive screws locking the cover securely closed. Wireways shall be UL or another NRTL listed, and shall be Square D Type LDB NEMA-1 enclosure for interior applications, or Type RDB NEMA-3R enclosure for exterior applications, or equal by Cooper B-line, Hoffman, Wire Guard, or Circle AW.
- I. Penetration in Fire-Rated Structures: Provide 3M, or equal, sealant and fire barriers for installing fire-rated seals around penetrations through floors, walls, and elevator hoistways. Fire stop system must be UL, or another NRTL listed, and classified for through-penetration applications of metallic conduits and busways.

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- J. Pull Wires: Install 1/8 inch polypropylene cords in empty or spare conduits.

PART 3 - EXECUTION

3.01 CONDUIT INSTALLATION

A. General Requirements:

1. Provide complete and continuous systems of rigid metallic conduit, outlet boxes, junction boxes, fittings and cabinets for systems of electrical wiring including lighting, power, and signal systems, except as otherwise specified.
2. EMT may be installed in interior concealed applications and in areas approved by owner. EMT shall not be installed in concrete, directly buried underground, outdoors, in boiler rooms, elevator pits, or where subject to damage.
3. Within buildings, flexible steel conduit may be installed instead of rigid steel conduit where permitted by code. Flexible steel conduit shall be installed:
 - a. For continuous lengths not exceeding more than 50 feet between pull points (pull boxes, outlet boxes, etcetera).
 - b. With no maximum total raceway length located within a building interior when the flex is located in concealed locations.
4. Flexible Steel conduit shall not exceed 1-1/2 inches in size.
5. Liquid-tight flexible steel conduit shall only be installed, except where otherwise specified, for final connection of motor terminal boxes, shop equipment, cafeteria equipment, HVAC equipment and other equipment, or for frequent interchange, and shall be of sufficient length, not exceeding 36 inches, to permit full travel or adjustment of motor on its base. Liquid-tight flexible conduit shall not be used for equipment not requiring adjustment or frequent interchange.
6. Connectors for flexible metal conduit shall be made of steel, and of the types which threads into convolutions of conduit. Connectors for watertight flexible metal conduit shall be as required for installation and shall be installed to provide a watertight connection.
7. Exposed conduit shall be installed vertically and horizontally following the general configuration of the equipment, using cast threaded hub conduit fittings where required and shall be clamped to equipment with suitable iron brackets and one hole pipe strap.
8. If connection is from a flush wall-mounted junction box, install an approved extension box.

9. Underground feeder distribution conduits for systems may be non-metallic conduit instead of rigid conduit except where otherwise specified or indicated.
10. Conduit shall be concealed unless otherwise indicated. Conduits exposed to view, except those in attic spaces and under buildings, shall be installed parallel or at right angles to structural members, walls, or lines of building. Conduits shall be installed to clear access openings.
11. Bends or offsets will not be permitted unless absolutely necessary. Radius of each conduit bend or offset shall be as required by ordinance. Bends and offsets shall be performed with standard industry tools and equipment or may be factory fabricated bends or elbows complying with

requirements for radius of bend specified. Heating of metallic conduit to facilitate bending is not permitted. Public telephone conduit bends and offsets shall be provided with a radius which is not less than ten times trade size of conduit unless otherwise permitted. Refer to underground installation, specified in this section, for radius of bends and offsets required for underground installations.

12. Running threads are not permitted. Provide conduit unions where union joints are necessary. Conduit shall be maintained at least six inches from covering of hot water and steam pipes and 18 inches from flues and breechings. Open ends of conduits shall be sealed with permitted conduit seals during construction of buildings and during installation of underground systems.
13. Expansion Joints/Seismic Separations/Separations between buildings/Locations Indicated: Provide Thomas & Betts XJG-TB, O-Z Electrical Mfg. Co. Inc. Type AX with bonding strap and clamps. Crouse Hinds XJGD, or equal. At exterior locations, provide Thomas & Betts XJG-TB, O-Z Electrical Mfg. Co. Inc. Type EX, Crouse Hinds XJGD, or equal. Provide Crouse Hinds, Thomas & Betts, or O-Z Electrical Mfg. Co. Type AXDX, or equal Combination Deflection/Expansion Fittings at all seismic separations. Provide manufactures internal and external Bonding Jumpers at all locations. Liquid-tight flexible conduit shall not be approved at expansion joints or seismic separations.
14. Where conduits are terminated in groups at panelboards, switchboards, and signal cabinets, etc., provide templates or spacers to fasten conduits in proper position and to preserve alignment. Conduits terminating at signal cabinets shall only enter cabinets in the following locations:
 - a. Conduits entering top, side, and bottom of cabinets shall be aligned in a single row, centered two inches from rear of cabinet.
 - b. Conduits entering back of cabinet shall be aligned in a single row centered two inches from top of cabinet.

- c. Conduits shall not be spaced closer than three inches on centers.
15. Conduits above metal lath ceilings shall be rigidly suspended with pipe hangers or pipe racks or shall be secured to superstructure with factory fabricated pipe straps. Conduits in metal lath or steel stud partitions shall be tied to furring channels or studs. In ceiling spaces and in partitions, tie wires shall be spaced not more than 5 feet apart, shall fasten conduit tight against channels and studs at point of tie and shall not support any of conduit weight. Tie wire shall be 16 gage galvanized double annealed steel.
 16. Where auxiliary supports, saddles, brackets, etc., are required to meet special conditions, they shall be fastened rigid and secure before conduit is attached.
 17. Conduit in ceiling spaces, stud walls, and under floors, shall be supported with factory fabricated pipe straps or shall be suspended with pipe hangers or pipe racks. Pipe straps shall be attached to and shall fasten conduit tight at point of support against ceiling and floor joists, rafters, and wall studs, or two-inch x four-inch headers fitted between joists or wall studs.
 18. Conduits installed on exposed steel trusses and rafters shall be fastened with factory fabricated conduit straps or clamps, which shall fasten conduit tight against supporting member at point of support.
 19. Conduits installed under buildings shall be strapped with factory fabricated conduit straps to underside of concrete floor or joists, or wood floor joists, or shall be suspended with pipe hangers or pipe racks. Conduits under building are not permitted to be placed directly on grade; they shall be suspended from building or shall be buried below surface or ground. 1-1/4 inch and larger conduits under buildings shall be installed with conduit hangers or racks.
 20. Pipe hangers for individual conduits shall be factory fabricated. Steel rods shall be 3/8 inch for two-inch conduit hangers and smaller and shall be 1/2 inch for 2 1/2-inch conduit hangers and larger.
 21. Pipe racks for groups of parallel conduits and for supporting total weights not exceeding 500 pounds shall be trapeze type and shall consist of a cross channel, Steel City Kindorf B-900, Unistrut P-1000, equivalent Cooper B-Line or equal, suspended with a 3/8 inch minimum diameter steel rod at each end. Rods shall be fastened with nuts, top and bottom to cross-channel and with square washers on top of channel. Conduits shall be clamped to top for cross-channel with conduit clamps, Steel City Kindorf C-105 or Unistrut P-1111 through P-1124, equivalent Cooper B-Line, or equal. Conduits shall not be stacked one on top of another, but a maximum of two tiers may be on same rack providing an additional cross-channel is installed. Where a pipe rack is to be longer than 24 inches, or if the supported weight exceeds 500 pounds, submit Shop Drawings of installation to the Architect for review.

22. Conduits suspended on rods more than two feet long shall be rigidly braced to prevent horizontal motion or swaying. Installation shall meet zone 4 seismic requirements.
23. Factory fabricated pipe straps shall be one or two-hole formed galvanized clamps, heavy-duty type, except where otherwise specified.
24. Hangers, straps, rods, or pipe supports under concrete shall be attached to inserts set at time concrete is placed, or with approved concrete anchors. Under wood, install bolts, lag bolts, or lag screws; under steel joists or trusses, install beam clamps. Contractor shall submit size of anchors, bolts, screws, and installation method to Architect for approval prior to start of any work.
25. Conduits shall be supported at intervals required by code, but not to exceed ten feet. One inch and smaller exposed conduits shall be fastened with one-hole malleable iron straps. Perforated straps and plumber's tape is not permitted for the support of conduits.
26. Conduits stubbed up through a roof or an arcade shall be flashed with a waterproof flashing. Refer to Division 07 for additional requirements.
27. Bushings and locknuts for rigid steel conduit shall be steel threaded insulating type. Setscrew bushings are not permitted.
28. Flex conduits shall be cut square and not at an angle.
29. Routing of conduits may be changed providing length of any conduit run is not increased more than ten percent of the length indicated on Drawings.

B. Underground Requirements:

1. Conduits and multicell raceways installed underground shall be entirely encased in three inch thick concrete on all sides , except where otherwise specified. Provide required spacers to prevent any deflection when concrete is placed and to preserve position and alignment. Conduits and raceways shall be tied to spacers. Anchors shall be installed to prevent floating of conduits and raceways during placing of concrete. Provide red colored concrete to encase conduits of systems operating above 600 volts.
2. Underground conduits and raceways shall be buried to a depth of not less than 24 inches below finished grade to top of the concrete envelope, unless otherwise specified.
3. Assemble sections of conduit with required fittings. Cut ends of conduit shall be reamed to remove rough edges. Joints in conduits shall be provided liquid-tight. Bends at risers shall be completely below surface where possible.

4. Conduits and raceways in a common trench shall be separated by at least three inches of concrete. Electrical power and/or lighting conduit runs installed in a common trench with conduits containing signal system wiring such as public address, telephone, intrusion detection, fire alarm, television, computer networking, and clock systems shall maintain a separation of a minimum of six inches from these types of signal system conduits and raceways. Electrical power, lighting and signal conduits and raceways installed in a common trench with other utility lines such as gas, water, sewer and storm lines shall maintain 12 inches separation from these types of utility lines.
5. The Inspector will observe underground installations before and during concrete placement. A mandrel shall be drawn through each run of conduit in presence of the Inspector before and after placing concrete. Mandrel shall be six inches in length minimum, and have a diameter that is within 1/4 inches of diameter of conduit to be tested.
6. Non-metallic conduit installations shall comply with following additional requirements. Joints in PVC conduit shall be sealed by means of required solvent-weld cement supplied by conduit manufacturer. Non-metallic conduit bends and deflections shall comply with requirements of applicable electrical code, except that minimum radius of any bend or offset for conduits sized from 1/2 inch to 1 1/2-inch inclusive shall not be less than

24 inches. Bends at risers and risers shall be PVC-coated rigid steel conduit. Radius of curve of bends or offsets in non-metallic conduit for public telephone system shall be not less than ten times trade size of conduit, unless otherwise specifically permitted.

7. Furnish and install a six-inch wide, polyethylene, red underground barrier type 12 inches above full length of concrete reading, "CAUTION ELECTRIC LINE BURIED BELOW".
8. Underground conduit systems provided for utility companies shall be furnished to meet the requirements of the utility companies requiring service.
9. Protect inside of conduit and raceway from dirt and rubbish during construction by capping openings.
10. Add bell-end bushings for conduit stub-up including underground entries to pull boxes, and manholes. Under floor standing switchboards and motor control centers provide a four-inch galvanized nipple with ground bushing.
11. Underground conduit for systems operating above 600 volts shall be a minimum size of four inches.
12. At portable classroom all stub ups shall be installed with a coupling flush to finish grade.
13. Underground conduits and raceways shall be swabbed prior to wire pull.

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- C. Rooftop conduit shall be supported from channels, stands, clamps, trapezes, rollers, or structures mounted on 100% rubber, UV resistant rooftop supports with reflective strips, Dura-Blok, or equal. Roller type supports shall be provided below and above conduit to prevent its dislodgement. Bottom of conduits shall clear the roof surface by 10 inches.
1. At PVC roofing provide walk tread, polyester reinforced, UV resistant, with surface embossment at rooftop supports. Heat welding of walk pads shall only be done by manufacturer certified installers.
 - a. Sika-Sarnafil and Carlisle: Walk tread shall be no more than one inch larger than the plan area of the pipe support blocks and adhered to the roof membrane with Sika 1A or Carlisle Universal Single-Ply sealant, as applicable.
 - b. Johns Manville: Walk tread shall be installed under the pipe support blocks and adhered to the blocks, if possible, and left loose laid on top of the PVC roof system. Walk-pad shall have a minimum of 4 inches of material past perimeter on all 4 sides of block.
 2. Built-up roofing: Provide APP granulated modified torch-down at each pipe support block. Torch-down shall extend 2 to 4 inches beyond the edges of the block and adhered by torch application over existing cap sheet membrane. This work shall be performed by a certified roofer.
- D. General Installation Requirements for Computer Network System Conduits:
1. Location of outlet boxes and equipment on Drawings is approximate, unless dimensions are indicated. Drawings shall not be scaled to determine position and routing of wireways, drops, and outlet boxes. Location of outlet boxes and equipment shall conform to architectural features of the building and other Work already in place and must be ascertained in the field before start of Work.
 2. The maximum pulling tensions of the specified cables shall not be exceeded and proper radius of cable bends shall be maintained.
 3. For computer network wiring, conduit types shall be limited to rigid metal conduit, electrical metallic tubing, schedule 40 PVC, multi-cell raceways, and flexible metallic conduit for lengths less than six feet.
 4. Interior section of conduit run shall be not longer than 100 feet and shall not contain more than two bends of 90 degrees between pull points or pull boxes.
 5. The inside radius of a conduit bend shall be at least six times the internal diameter of the conduit. When the conduit size is greater than two inches, the inside radius shall be at least ten times the internal diameter of the

conduit. For fiber-optic cable, the inside radius of a conduit bend shall be at least ten times the internal diameter of the conduit.

6. Conduit shall be sized in accordance with Table 4.4-1 of EIA/ TIA 569 standard.
7. Splicing or terminating cables in pull boxes is not permitted.
8. For indoor application, a pull box shall be provided in conduit run where:
 - a. The length is over 100 feet.
 - b. There are more than two bends of 90 degrees.
 - c. There is a reverse bend in the run.
9. Boxes shall be provided in a straight section of conduit and shall not be installed in lieu of a bend. The corresponding conduit ends are to be aligned with each other. Conduit fittings shall not be installed in place of pull boxes.
10. Where a pull box is provided with raceways, pull box shall comply with the following:
 - a. For straight pull-through, provide a length of at least eight times the trade-size diameter of the largest raceway.
 - b. For angle and U-pulls:
 - 1) Provide a distance between each raceway entry inside the box and the opposite wall of the box of at least six times the trade-size diameter of the largest raceway, this distance being increased by the sum of the trade-size diameters of the other raceways on the same wall of the box.
 - 2) Provide a distance between the nearest edges of each raceway entry enclosing the same conductor of at least:
 - a) Six times the trade-size diameter of the raceway; or
 - b) Six times the trade-size diameter of the larger raceway if they are of different size.
 - c) For a raceway entering the wall of a pull box opposite to a removable cover, provide a distance from the wall to the cover of not less than the trade-size diameter of the largest raceway plus six times the diameter of the largest conductor.
11. Drawings generally indicate Work to be installed, but do not indicate all bends, transitions of special fittings required to clear beams, girders or

other Work already in place. Investigate conditions where conduits and wireways are to be installed, and furnish and install required fittings.

E. Slabs on Grade:

1. Unless specifically reviewed by the Architect and DSA, conduits 1 ¼-inches and larger are not permitted to be installed in structural concrete slabs. Where conduits are permitted, and are installed in concrete slabs on grade, slabs shall be thickened at bottom where conduits occur to provide three inches of concrete between conduit and earth. Required excavation shall be part of the Work of this section.
2. If concrete slab is five inches or more in thickness with a moisture barrier plastic sheet between earth and slab, one inch and smaller conduits shall be installed in the slab with a minimum of one inch concrete between earth and conduit.

F. Concrete Walls, Beams, and Floors: Provide sleeves where conduits pierce concrete walls, beams, and floors, except floor slabs on grade. Sleeves shall provide 1/2 inch clearance around conduits. Sleeves shall not extend beyond exposed surfaces of concrete and shall be securely fastened to forms. Where conduits pass through walls below grade, seal with required sealant and backer materials between conduit and sleeve to provide a watertight joint. Sealant shall be as indicated in Section 07 9200: Joint Sealants.

3.02 STUBS

- A. Panelboard: Install two one inch conduits from each flush mounted panelboard to access under floor space and to access above ceiling space where these conditions occur. Cap conduits with standard galvanized pipe caps.
- B. Floor: At points where floor stubs are indicated in open floor areas, for connections to machines and equipment, conduits shall be terminated with couplings, tops flush with finished floor. Stubs shall extend above couplings the indicated distance.

Where capped stubs are designated, couplings shall be closed with cast iron plugs with screw drive slots.

C. Underground:

1. Underground conduit stubs shall be terminated at locations indicated, and shall extend five feet beyond building foundations, steps, arcades, concrete walks and paving. Rigid metallic conduit stubs and non-metallic conduit stubs shall be capped by installing a coupling flush in end wall of concrete encasement and plugging with a permitted plug. Project record drawings shall indicate location of ends of underground conduit stubs fully dimensioned and triangulated with reference to buildings or permanent landmarks. These dimensions, including depth below finished grade, shall be marked on project record drawings in presence of the Inspector before backfilling trench. Where extending existing concrete encased stubs, clean,

chip and wire brush end of existing concrete and brush on a heavy coat of neat cement paste or epoxy bonding agent.

2. Over ends of individual underground conduit stubs or groups of conduit stubs, install four-inch by 18-inch deep PVC filled with concrete, flush with finished grade in asphaltic concrete or lawns, and two inches above finished grade in planting areas. Cast a three-inch by three-inch brass plate engraved "ELECT" flush in top of concrete. Secure plate to concrete with brass dowels or as indicated on drawings.

3.03 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.04 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 26 0543
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Ducts in concrete-encased duct banks.
 - 2. Handholds and hand hole accessories.
 - 3. Manholes and manhole accessories.
- B. Related Sections include the following:
 - 1. Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding electrodes, counterpoise conductors, clamps and connectors for grounding metallic manhole and hand hole accessories, and testing of grounds.

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Manhole and hand hole hardware.
 - 2. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
 - 3. Duct-bank materials, including spacers and miscellaneous components.
 - 4. Warning tape.
- B. Shop Drawings: Show fabrication and installation details for underground ducts and utility structures and include the following:
 - 1. For manholes:
 - a. Duct sizes and locations of duct entries.
 - b. Reinforcement details.
 - c. Manholes cover design.
 - d. Step details.
 - e. Grounding details.
 - f. Dimensioned locations of cable rack inserts, pulling-in irons, and sumps.
 - 2. For precast manholes and hand holes, Shop Drawings shall be signed and sealed by a qualified professional engineer, and shall show the following:
 - a. Construction of individual segments.
 - b. Joint details.
 - c. Design calculations.

- C. Coordination Detailing Activity Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to scale, and show all bends and location of expansion fittings. Refer to Division 01 Section, "Coordination and Detailing Activity".
- D. Product Certificates: For concrete and steel used in underground precast manholes, according to ASTM C 858.
- E. Product Test Reports: Indicate compliance of manholes with ASTM C 857 and ASTM C 858, based on factory inspection.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories Including Ducts for Communications and Telephone Service: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the University's Representative, and marked for intended use.
- B. Comply with ANSI C2.
- C. Comply with California Electric Code (NFPA 70).

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied the University or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify the University's Representative fourteen days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without University Representative's written permission.

1.6 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities and site grading, as determined in the field.

- B. Coordinate elevations of ducts and duct-bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure duct runs drain to manholes and handholes, and as approved by the University's Representative.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of amount installed.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Underground Precast Concrete Utility Structures:
 - a. Carder Concrete Products.
 - b. Christy Concrete Products, Inc.
 - c. Elmhurst-Chicago Stone Co.
 - d. Jensen Precast.
 - e. Utility Vault Co.
 - f. Wausau Concrete Co.
 - g. Or equal.
 - 2. Frames and Covers:
 - a. Alhambra Foundry
 - b. Campbell Foundry Co.
 - c. East Jordan Iron Works, Inc.
 - d. McKinley Iron Works, Inc.
 - e. Neenah Foundry Co.
 - f. Or equal.
 - 3. Nonmetallic Ducts and Accessories:
 - a. Arnco Corp.
 - b. Beck Manufacturing Inc.
 - c. Cantex, Inc.
 - d. Certainteed Corp.; Pipe & Plastics Group.
 - e. ElecSys, Inc.
 - f. Electri-Flex Co.

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- g. Lamson & Sessions; Carlon Electrical Products.
- h. Manhattan/CDT/Cole-Flex.
- i. Spiraduct/AFC Cable Systems, Inc.
- j. Or equal.

- B. Or Equal: Where products are specified by manufacturers name and accompanied by the term "or equal", comply with provisions in Division 01 Section "Product Requirements", Part 2 "Product Substitutions" Article. Specific procedures must be followed before use of an unnamed product or manufacturer.

2.2 CONDUIT

- A. Conduit and fittings are specified in Division 26 Section "Raceways and Boxes for Electrical Systems."

2.3 DUCTS

- A. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.4 HAND HOLES

- A. Cast-Metal Boxes: Cast aluminum, with outside flanges and recessed, gasketed cover for flush mounting and with nonskid finish and legend on cover. Unit, when buried, shall be designed to support AASHTO H10 loading for sidewalk and landscaped areas and HS20 for roadways, parking lots and loading docks.
- B. Precast Handholes: Reinforced concrete, monolithically poured walls and bottom, with steel frame and access door assembly as the top of hand hole. Duct entrances and windows shall be located near corners to facilitate racking. Pulling-in irons and other built-in items shall be installed before pouring concrete. Cover shall have nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading for sidewalk and landscaped areas and HS20 for roadways, parking lots and loading docks.
- C. Cover Legend: "ELECTRIC."

2.5 PRECAST MANHOLES

- A. Precast Units: ASTM 478, with interlocking mating sections, complete with accessories, hardware, and features as indicated. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
- B. Diameter: 48 inches minimum.
- C. Design and fabricate structure according to ASTM C 858.
- D. Structural Design Loading: ASTM C 857, Class A-16 (AASHTO HS20).

- E. Base section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
- F. Riser Sections: 4-inch minimum thickness, and lengths to provide required depth Approved by University Representative.
- G. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
- H. Steps: ASTM A 615, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 36 inches.
- I. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
- J. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
- K. Protective Coating: Plant-applied, coal-tar, epoxy-polyamide paint 15-mil minimum thickness applied to exterior and interior surfaces.
- L. Source Quality Control: Inspect structures according to ASTM C 1037.

2.6 ACCESSORIES

- A. Duct Spacers: Rigid PVC interlocking spacers, selected to provide minimum duct spacings and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts.
- B. Manhole Frames and Covers: Comply with AASHTO loading specified for manhole; Ferrous frame 36 inch clear ID by 6 inch minimum riser with 4-inch-minimum width flange and 38 -inch-diameter cover.
 - 1. Provide cast covers with cast-in legend:
 - a. "UCI LV-ELECTRIC" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. "UCI HV-ELECTRIC" for duct systems with medium-voltage cables.
 - c. "UCI COMMUNICATIONS" for communications, data, and telephone duct systems.
 - 2. Cast iron with cast-in legend as indicated above subsection 1. Milled cover-to-frame bearing surfaces.
 - 3. Manhole Frames and Covers: ASTM A 48; Class 30B gray iron, 36-inch size, machine-finished with flat bearing surfaces.
- C. Sump Frame and Grate: ASTM A 48, Class 30B gray cast iron.

- D. Pulling Eyes in Walls: Eyebolt with reinforcing-bar fastening insert 2-inch- diameter eye and 1-by-4-inch bolt.
 - 1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- E. Pulling and Lifting Irons in Floor: 7/8-inch- diameter, hot-dip-galvanized, bent steel rod; stress relieved after forming; and fastened to reinforced rod. Exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- F. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- H. Cable Stanchions: Hot-rolled, hot-dip-galvanized, T-section steel; 2-1/4-inch size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
- I. Cable Arms: 3/16-inch- thick, hot-rolled, hot-dip-galvanized, steel sheet pressed to channel shape; 12 inches wide by 14 inches long and arranged for secure mounting in horizontal position at any location on cable stanchions.
- J. Cable-Support Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- K. Grounding Materials: Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."
- L. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and of adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- M. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

2.7 CONSTRUCTION MATERIALS

- A. Seal manhole section joints with sealing compound recommended by the manhole manufacturer.
- B. Damp proofing: Comply with Division 07 Section "Bituminous Damp proofing."

- C. Mortar: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.
- D. Brick for Manhole Chimney: Sewer and manhole brick, ASTM C 32, Grade MS.
- E. Concrete: Use 3000-psi- minimum, 28-day compressive strength and 1-inch maximum aggregate size. Concrete and reinforcement are specified in Division 03 Section "Cast-in-Place Concrete." Provide red dye added to concrete during batching for medium voltage as follows:
 - 1. 2.0 lbs. of dye per 94 lb. bag of cement.
 - a. Color: Davis Color No. 1117.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Underground Ducts for Electrical Cables Higher Than 600 V: Type EPC-40-PVC, concrete-encased duct bank.
- B. Underground Ducts for Telephone Utility Service: Type EPC-40-PVC, direct-buried duct bank, except use Type EPC-80-PVC when crossing roads.
- C. Underground Ducts for Communication Circuits: Type EPC-40-PVC, direct-buried duct bank, except use Type EPC-80-PVC when crossing roads.
- D. Manholes: Underground precast concrete utility structures.
- E. Manholes: Cast-in-place concrete.

3.2 EARTHWORK

- A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving" but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Section.
- D. Restore disturbed pavement. Refer to Division 01 Section "Cutting and Patching."

3.3 CONDUIT AND DUCT INSTALLATION

- A. Exercise care in excavating, trenching, and working near existing utilities. Locate any existing buried utilities before excavating.
- B. Duct bank trench shall be shored, framed and braced for installing ducts. Frames, forms, and braces shall be either wood or steel. Variations in outside dimensions of the installed duct bank shall not exceed 2 inches on the vertical or the horizontal from the design. Remove forms and bracing after 24 hours and before backfilling.
- C. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions. Duct banks shall be laid to a minimum grade slope of 4 inches per 100 feet. This slope may be from one manhole to the next or both ways from a high point between manholes, depending upon the contour of the finished grade.
- D. Duct banks shall be installed so that the top of the concrete encasement shall be no less than 36 inches below grade or pavement for primary 12K power, and not less 24 inches below finished grade or pavement for campus-wide communications. As a general rule, depths shall be a minimum of three feet, but not more than six feet.
- E. Curves and Bends: Use manufactured 60 inches minimum elbows for stub-ups at equipment, communication pull boxes or enclosures and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet, both horizontally and vertically, at other locations. Manufactured long radius bends may be used in runs of 100 feet or less on approval from the University's representative. Vertical feeder sweep into buildings shall be coated steel.
- F. Use solvent-cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- G. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches o.c. for 5-inch ducts and vary proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances. Where connection to bulkhead of duct bank is made to vaults or existing duct banks, the concrete encasement shall be doweled with on No. 4 reinforcement rod 36 inches long per conduit to the existing encasement.
- H. Building Entrances: Make a transition from underground duct to conduit at least 10 feet outside the building wall. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:
 - 1. Concrete-Encased Ducts: Install reinforcement in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
 - 2. Direct-Buried, Non-encased Ducts at Non-waterproofed Wall Penetrations: Install a Schedule 40, galvanized steel pipe sleeve for each duct. Calk space between conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.

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3. Waterproofed Wall and Floor Penetrations: Install a watertight entrance-sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.
- I. Concrete-Encased, Nonmetallic Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:
1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 2. Duct joints in concrete may be placed side by side horizontally, but shall be staggered at least 6 inches vertically. Joints shall be made in accordance with manufacturer's recommendations for the particular type of duct and coupling selected. In the absence of specific recommendations, plastic duct connections shall be made by brushing a plastic solvent cement on the inside of a plastic coupling fitting and on the outside of duct's ends. The duct and fitting shall then be slipped together with a quick one-quarter turn to set the joint.
 3. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope. At connection to manholes, dowel concrete encasement with one No. 4 reinforcing bar 36 inches long per duct.
 4. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.
 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 6. Minimum Clearances between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
 7. Depth: Install top of duct bank at least 24 inches below finished grade in no traffic areas and at least 30 inches below finished grade in vehicular traffic areas, unless otherwise indicated.
- J. Direct-Buried Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:
1. Separator Installation: Space separators not more than 4 feet center-to-center along entire length of duct bank including top pipes.
 2. Install expansion fittings as shown on Shop Drawings.

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3. Trench Bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
 4. Backfill: Install backfill as specified in Division 31 Section "Earth Moving." After installing first tier of ducts, backfill and compact. Repeat backfilling after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, complete backfilling normally. Do not place backfill for a period of at least 24 hours after pouring of concrete.
 5. Minimum Clearances between Ducts: 3 inches between ducts for like services and 6 inches between power and signal ducts.
 6. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
- K. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank.
- L. Stub-ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete. Galvanized steel conduits installed below grade shall be painted with two coats of Koppers Bitumastic paint before installing in ground.
- M. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- N. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

3.4 MANHOLE AND HANDHOLE INSTALLATION

- A. Elevation: Install manholes with rooftop at least 15 inches below finished grade. Install handholes with depth as indicated. Where indicated, cast hand hole cover frame directly into roof of hand hole and set roof surface 1 inch above grade. Place and align precast manholes to provide horizontal tolerance of 2 inches in any direction and vertical alignment with not greater than 1/8 inch maximum tolerance for 6 foot of depth. Completed manhole shall be rigid, true to dimensions and alignment, and shall be watertight.
- B. Drainage: Install drains in bottom of units where indicated. Coordinate with drainage provisions indicated. Sumps shall be knocked out at time of installation.
- C. Access: Install cast-iron frame and cover.
1. Install precast collars and rings to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
 2. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1 inch above finished grade.

- D. Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least three days. Apply according to Division 07 Section "Cold-Fluid Applied Water Proofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole and hand hole chimneys after brick mortar has cured at least three days. Seal manhole section joints with sealing compound recommended by the manhole manufacturer. Penetration into manholes and/or boxes shall be sealed. Provide conduit duct plugs for unused terminator openings of spare conduits in manhole. Do not water seal top removable cover until cable pulling has been completed.
- E. Damp proofing: Apply damp proofing to exterior surfaces of units after concrete has cured at least three days. Apply according to Division 07 Section "Bituminous Damp proofing." After ducts have been connected and grouted, and before backfilling, damp proof joints and connections and touch up abrasions and scars. Damp proof exterior of manhole and hand hole chimneys after brick mortar has cured at least three days.
- F. Interior walls and ceiling shall be primed and painted with two coats flat white paint.
- G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- H. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8 inches for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- I. Grounding: Install ground rod through floor in each structure with top protruding 6 inches above floor. Seal floor opening against water penetration with waterproof nonshrink grout. Ground exposed metal components and hardware with bare-copper ground conductors. Train conductors neatly around corners. Use cable clamps secured with expansion anchors to attach ground conductors.
- J. Precast Concrete Manhole Installation: comply with ASTM C 891.
 - 1. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - 2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth. Provide a minimum 6-inch level base of $\frac{3}{4}$ inch crushed rock under manhole to ensure uniform distribution of soil pressure on floor.

3.5 FIELD QUALITY CONTROL

- A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
- B. Grounding: Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

- C. Duct Integrity: Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of the duct. If obstructions are indicated, remove obstructions and retest.
- D. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

3.6 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.
- C. After the duct line has been completed, a brush with stiff bristles shall be pulled through each duct to make certain that no particles of earth, sand or gravel have been left in the line. (Mandrels not less than 12 inches long, having a diameter approximately 1/4 inch less than inside diameter of the duct, shall be pulled through each duct). Leave a 3/8"-inch minimum polypropylene pull rope in each duct for future use.

END OF SECTION

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.

1.2 PRODUCTS

- A. Power and Control Raceway Identification: Vinyl labels.
- B. Power and Control Cable Identification: Vinyl labels and Metal tags.
- C. Conductor Identification: Color-coding conductor tape.
- D. Floor Marking Tape: Pressure-sensitive vinyl tape.
- E. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, polyethylene tape, with embedded continuous metallic strip or core.
- F. Warning Labels and Signs: Baked-enamel warning signs.
- G. Instruction Signs: Engraved, laminated acrylic or melamine plastic.
- H. Equipment Identification Labels: Engraved, laminated acrylic or melamine plastic.

1.3 APPLICATION

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Printed Legend:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

1.4 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- B. Fabricated Nameplates Shall Clearly State the Following:
 - 1. Manufacturer's name and equipment design ratings including current, voltage, KVA.
 - 2. System nominal voltage, equipment rating KVA, amperes.
 - 3. Panel designation, voltage and phase.
- C. Manufacturer's Device Nameplates: Circuit number; manufacturer and electrical characteristic ratings including the following:
 - 1. Circuit Breakers: Voltage, maximum interrupting current and trip current.
 - 2. Switches: Voltage, horsepower or maximum current switching. If fused, include nameplate stating "Fuses must be replaced with current limiting type of identical characteristics."
 - 3. Contactors: Voltage, continuous current, horsepower or interrupting current, and whether "mechanically held" or "electrically held."
- D. Controllers: Voltage, current.

1.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength: 50lb, minimum
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color coding.
- B. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

1.6 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

- E. Attach signs and plastic labels that are not self-adhesive type with screws and auxiliary hardware appropriate to the location and substrate.

- F. Color Coding for Phase and Voltage Level Identification, 600V and Less:
 - 1. Colors for 208/120V Circuits;
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Phase C: Blue
 - d. Neutral: White
 - e. Ground: Green
 - 2. Colors for 480/277V Circuits;
 - a. Phase A: Brown
 - b. Phase B: Yellow
 - c. Phase C: Purple
 - d. Neutral: Gray

- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

1.7 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
 - 1. Fire Alarm System: Red.

- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

- C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.

- D. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source and circuit number.

- E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- F. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- G. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- H. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Screwed-on engraved white laminated plastic sheet with minimum 3/8 inch to 3/4 inch black lettering for normal systems and red laminated plastic sheet with lettering for emergency systems.
 - b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 2. Equipment to Be Labeled:
 - a. Identification labeling of some items listed below may be required by individual Sections or by CEC.
 - b. Panelboards, electrical cabinets, and enclosures.
 - c. Switchgear.
 - d. Switchboards.
 - e. Transformers.
 - f. Substations.
 - g. Emergency system boxes and enclosures.
 - h. Motor-control centers.
 - i. Enclosed switches.
 - j. Enclosed circuit breakers.
 - k. Enclosed controllers.
 - l. Power transfer equipment.
 - m. Contactors.
 - n. Remote-controlled switches, dimmer modules, and control devices.
 - o. Battery-inverter units.
 - p. Battery racks.
 - q. Power-generating units.

- r. Monitoring and control equipment.
- s. UPS equipment.
- t. Fire-alarm control panel and annunciators.

- I. Devices: P-Touch adhesive label on each device plate with 3/16" high block letters in black where noted and as follows:
 - 1. Lock switch and switch with pilot light – device controlled.
 - 2. Switch for fan, motor, unit heater – equipment controlled.
 - 3. Switch where lights or equipment are out of sight – equipment controlled.
 - 4. Switches in gangs of three or more – description of lights or equipment switched.
 - 5. All receptacles and switches – panel and circuit number reflecting installed condition.
 - 6. All equipment on the normal and emergency systems – panel and circuit number reflecting installed condition.
 - 7. Receptacles over 150V to ground and/or 30A and higher rating – voltage and ampere rating.
 - 8. Where wording is not indicated, allow for ten letters per device and use wording as directed.

- J. For switch cabinets engrave each device or furnish engraved nameplate.

END SECTION

SECTION 26 2200
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: This specification covers single-phase and three-phase general purpose individually mounted dry-type transformers, 600 V maximum, for power and lighting applications. It includes transformers as specified and as indicated on Drawings.
- B. Work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.
- C. Codes and Applicable standards: Products and installation shall meet or exceed the latest edition of the following standards.
 - 1. ANSI/IEEE C57.96, Distribution and Power Transformers, Guide for Loading Dry-Type Transformers; Appendix to ANSI C57.12 Standards.
 - 2. Department of Energy, Energy Act of 2005.
 - 3. International Electrical Code adopted by the State of California.
 - 4. ANSI/NEMA 250 Enclosure for Electrical Equipment (1000 Volts Maximum)
 - 5. IEEE C57.12.91, Test Code for Dry-Type Distribution and Power Transformers.
 - 6. IEEE C57.110 – IEEE Recommended Practice for establishing liquid-filled and dry-type power and distribution transformer capability when supplying nonsinusoidal load currents.
 - 7. 1100-IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.

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8. NEMA standard 20, Dry-Type Transformers for General applications.
 9. UL 506, Specialty Transformers.
 10. UL 1561, Dry-Type General Purpose and Power Transformers.
 11. NEMA TP-1, Guide for Determining Energy Efficiency for Distribution Transformers.
 12. NEMA TP-2, Standard Test Method for Measuring the Energy Consumption of Distribution Transformers.
 13. NEMA TP-3, Standard for the Labeling of Distribution Transformer Efficiency.
 14. CSA 802.2-00 Minimum Efficiency Values for Dry Type Transformers
 15. California Building Code (CBC)
 16. NFPA 70 National Electric Code
- D. No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Owner Authorized Representative by the CONTRACTOR.

E. ACRONYMS

ANSI	American National Standards Institute
AOR	Architect of Record
CEC	California Electrical Code
EOR	Engineer of Record
IBC	International Building Code
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical manufacturers Association

1.02 DESIGN REQUIREMENTS

- A. Premium Efficiency transformers with internal losses at 35 percent loading reduced by 30 percent when using temperature and material correction factor to 75 degrees C per NEMA Standard TP1
- B. Load Mix: Transformer shall be UL 1561 listed to feed a mix of equipment load profiles such as computer without detracting or significant degradation of efficiency.
- C. The transformer shall be labeled with a K-9 Rating in accordance with UL 1561 35.21 and 34.2.
- D. K-7 rating is not allowed.
- E. Construction: Windings shall be continuous wound copper with brazed or welded terminations.
 - 1. Insulation and Varnish Systems: Epoxy Polyester impregnation
 - 2. Terminals, including those for changing taps must be readily accessible by removing a front cover plate.
- F. Performance of transformers shall meet or exceed the requirements of applicable codes and standards, the DOE Energy Policy Act of 2005 - Public Law 109-58 and the latest requirements of the California Energy Commission Appliance Efficiency Regulations. In addition; transformers shall be designed to an efficiency standard higher than the lowest legal standard for the purpose of contributing to LEED Energy and Atmosphere (Optimized Energy Performance) and Utility Rebates.
- G. Transformers shall be self-cooled type with 220 degrees C. insulation and a maximum temperature rise of 130 degrees C. under continuous full load conditions with an ambient of 40 degrees C.
- H. Transformers shall be furnished with four 2.50 percent (two above and two below normal voltage) taps. Windings shall be of fire-resistant type, designed for natural convection cooling through normal air circulation.

- I. Core mounting frames and enclosures shall be of welded and bolted construction with sufficient mechanical strength and rigidity to withstand shipping, installation, and short circuit stresses.
- J. Enclosure cover plates shall be sheet steel, captive bolted to enclosure framework. Enclosure shall provide suitable ventilating openings with rodent-proof screens, NEMA 1 enclosure. Enclosure shall be provided with lifting lugs and jacking plates as required. Transformers installed outdoors shall be provided with weatherproof NEMA 3R enclosure and weather proof kit.
 - 1. Submit rodent-proof screen sample for OWNER's approval.
- K. Transformers shall be furnished complete with mounting channels and mounting bolts. Metal parts, excepting cores and core mounting frames shall be furnished clean, rust-proofed, and provided with a coat of an inert primer.
- L. Transformers up to 35 KVA shall not exceed 40 decibels. Transformers 36 KVA or more shall be a minimum of 5 decibels below NEMA standards per unit. Transformers shall be provided with vibration dampers consisting of California Dynamic, Mason Industries, Korfund or equal neoprene mounting pad and Elastorib sheeting. Size and number of shock mounts shall be in accordance with manufacturer's recommendations.
- M. Transformers shall be UL listed.
- N. Each transformer to be installed under this section shall be sound tested at the factory. CONTRACTOR shall provide two copies of transformers tests reports for EOR's review.
- O. Equipment shown on drawings to scale is approximate only and based upon a general class of equipment specified. The CONTRACTOR shall verify dimensions and clearances prior to commencement of work.
- P. Verify points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. Actual dimensions, weights, clearances and installation requirements shall be verified and coordinated by the CONTRACTOR.

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1.03 SUBMITTALS

- A. Provide in accordance with Division 01.
- B. Shop Drawings: Include make, catalog number, dimensions, weight, KVA Rating, Percent Impedance, finish, type, insulation class, design temperature, sound levels, efficiency and taps provided. Include regulation at 80 percent and 100 percent of full load, no-load loss, full-load loss, percent efficiency, percent impedance, noise level and continuous capacity rating.
- C. Provide manufacturers data and inspection report that confirms transformers to be UL 1561 listed with K rating equal to that indicated on drawings.
- D. Provide a connection schematic diagram.
- E. Provide the following tests reports: Project Inspector will review the reports for conformance with specified criteria, and compliance with the applicable standards. Submit one copy for each set of shop drawings being submitted.
 - 1. Load Losses: Measurements shall be taken at multiple load levels and plotted to show compliance with specifications and correlated to efficiency curve for the transformer size and type.
 - 2. Provide No-Load and Total Losses report.
 - 3. Applied Voltage.
 - 4. Temperature Rise.
 - 5. Induced Voltage.
 - 6. Sound Level.
 - 7. Impulse Test.
 - 8. Manufacturer's nonlinear load test representing real world load mix. Transformers not meeting this requirement shall not be installed.
- F. Submit harmonics test plan as follows:

1. NEMA ST-20.
 - a. Open Circuit Test (no load losses):
 - 1) Use for both Linear and non-Linear.
 - 2) Measure Power.
 - b. Short Circuit Test (load losses):
 - 1) Short Primary Winding.
 - a) Linear Test – complete with linear profile through secondary winding.
 - c. Non-Linear Test.

Harmonic Profile (K-7 Load)				
Harmonic Number	Rated % Current	Phase Shift		
		A	B	C
1	100.0	0	120	240
3	81.0	0	0	0
5	60.6	0	240	120
7	37.0	0	120	240
9	15.7	0	0	0
11	2.4	0	240	120
13	6.3	0	120	240
15	7.9	0	0	0

- 1) Complete with non-linear profile through secondary windings.
 - 2) Measure Power.
2. Take data and graph efficiency per NEMA ST-20.
 - a. Graph-1 – Linear Loads 0 to 100 Percent Loads.
 - b. Graph 2 – Non-Linear Profile K-9 0 to 100 Percent loads.

3. Test Plans measuring Power IN and Power Out will not be accepted since procedures are not covered by any standard.

1.04 WARRANTY

- A. Transformers shall be warranted to be free from defects in materials, fabrication and execution for a period of three years from the date of substantial completion.

PART 2 - PRODUCTS

2.01 EQUIPMENT

- A. Transformers manufactured by Siemens, Square D, General Electric, PowerSmiths, MGM, and Cutler Hammer or equal.
- B. There shall be no openings through which foreign objects such as sticks, rods, wires, or the like might enter and contact live parts. Provide means for padlocking compartment doors.
 - a. Connection terminal points shall be bottom fed and located as far as possible below vent openings, or below top connections.
 - b. Terminals shall be protected from external/foreign objects contact.

PART 3 - EXECUTION

3.01 DELIVERY AND STORAGE

- A. Deliver, storage, protect and handle products in accordance with the manufacturer's recommendations.

3.02 INSTALLATION

- A. Transformer core frame shall be installed level on shock absorbing pads within enclosure. Comply with seismic requirements of CBC.
- B. Mounting bolts on floor mounted transformers shall be extended into pads only and shall not be in direct contact with building structural members.

- C. Flexible jumpers shall be installed for grounding continuity from enclosure to conduits or bus ducts where required.
- D. Transformers installed outdoors or below grade shall be mounted on concrete pads as specified in Section 03 3000: Cast-In-Place Concrete.
- E. Install transformer ventilation openings not closer than 6 inches from wall surfaces.
- F. Do not install transformers in corrosive environments such as swimming pool pump and boiler rooms, or similar areas.

3.03 VOLTAGE CHECK

- A. Set taps on transformers to provide satisfactory operating voltages with present loads energized, including new loads and existing loads. A check shall be performed in the presence of the Project Inspector at a panel fed from each transformer, which is farthest from transformer. Voltages at transformers ranging from 118 to 122 volts inclusive, for 120 volt systems and proportionately equivalent for higher voltage systems are permitted.
- B. Provide instruments and accessories required to perform checks. Voltmeters shall be accurate within .075 percent or one percent and shall have scales permitting voltage readings to be performed on upper half of scale. Calibration of the meters shall be observed by the Project Inspector.
- C. Adjust transformer taps under full load operating conditions, to provide normal operating voltages at the loads.

3.04 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.05 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off Project site.
- B. Repair scratched or marred surfaces affected during the execution of work. Repair surfaces shall match original finish.

END OF SECTION

SECTION 26 2416
PANELBOARDS AND SIGNAL TERMINAL CABINETS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Lighting and power distribution facilities, including panelboards.
- B. Related Requirements:
 - 1. Division 01 - General Requirements.
 - 2. Section 26 0500: Common Work Results for Electrical.
 - 3. Section 26 0513: Basic Electrical Materials and Methods.

1.02 SUBMITTALS

- A. Provide in accordance with Division 01.
- B. Shop Drawings: Include a front elevation indicating cabinet dimensions, make, location and capacity of equipment, size of gutters, type of mounting, finish, and catalog number of locks. General layout of internal devices, wiring drawings with wire numbers and device connections, vendor cut sheets of devices in enclosure and bill of materials listing description, manufacturer, part number, and quantity of items shall be included.
- C. Installation Instructions: Submit manufacturer's written installation instructions.

1.03 DESIGN REQUIREMENTS

- A. Panelboards:
 - 1. Panelboards shall be wall-mounted, enclosed safety type with 120/240 volt, three-wire solid neutral 277/480 volt, four-wire or 120/208 volt, four-wire solid neutral mains as indicated on Drawings or specified. First panelboard of each building shall be provided with main or sub-feeder circuit breakers where so indicated.
 - 2. Single pole branches shall be molded case, thermal magnetic circuit breakers with inverse time delay, trip free, quick-make, quick-break mechanism and silver alloy contacts. Circuit breakers shall be fully rated, with ampere rating marked on handle and shall indicate on/off and tripped positions. Ground fault interrupters shall be incorporated into circuit breakers where indicated. They shall be listed by UL, or other NRTL as

ground fault devices. Provide appropriate lug kit of sufficient size to accommodate the feeders.

3. Two- and three-pole branches shall be enclosed, and shall be thermal magnetic circuit breakers with inverse time delay, tamper-proof, ambient compensated, single handle, internal common trip, and quick-make, quick-break mechanism with silver alloy contacts. Circuit breakers shall be fully rated or as otherwise indicated on the Drawings.
 4. Main and subfeeder circuit breakers shall be enclosed, thermal magnetic type with inverse time delay, single handle common trip, quick-make, quick-break mechanism, corrosion-resistant bearings and silver alloy contacts. Ampere frame size and trip rating shall be as indicated on Drawings. Breakers over 225 amperes shall be furnished with interchangeable trip units. Handles of main and subfeeder circuit breakers shall be provided cabinet door. Voltage rating shall be as indicated on Drawings.
 5. Circuit breakers shall be fully rated and of one-piece, bolt-on type and shall meet short-circuit interrupting capacity requirements indicated on Drawings. Series rated circuit breaker combinations are not acceptable.
 6. Internal connections shall be fabricated with plated copper bus bars and the busses shall extend for full length of space available for branch circuit breakers. Feeder cable connectors shall be installed at point of feeder entrance. Terminals shall be furnished with copper conductors. Panelboards fed by conductors having over-current protection greater than 200 amperes shall be protected on supply side by over-current devices having a rating not greater than that of panelboards. Copper bussing shall be fully rated. Heat rated bussing is not acceptable.
 7. Except where otherwise indicated, circuit breakers shall be in two vertical rows connected to bus bars in a distributed phase arrangement. Two-pole branches shall be balanced on busses. Single pole branches shall be numbered adjacent to its circuit breaker, with odd numbers on left and even numbers on right.
 8. Specified circuit breaker spaces shall be furnished with hardware required for future installation of circuit breakers.
 9. Provide locking devices for individual circuit breakers. Padlocking devices shall be secured to circuit breakers and by panel dead front plates.
- B. Surge Suppressors: Where indicated on Drawings, provide transient voltage surge suppressors as an integral part of panelboards. Panelboards shall be complete with 200 percent rated copper neutral bus, ground bus and isolated ground bus in addition to requirements of this section. Surge suppressors shall be as follows:

1. Surge Capacity:
 - a. Line-to-neutral for wye systems: 80 KA.
 - b. Line-to-ground: 80 KA.
 - c. Neutral-to-ground: 80 KA, three-phase wye.
 - d. Line-to-neutral plus line-to-ground: 160 KA.
2. UL 1449 2nd Edition Suppressed Voltage Rating for 208/120 Wye System:
 - a. Line-to-neutral: 400 volts.
 - b. Line-to-ground: 400 volts.
 - c. Neutral-to-ground: 400 volts.
 - d. Maximum continuous over-voltage: 150 volts.
3. EMI/RFI High-Frequency Noise Power Filter (Characteristics):
 - a. 100 KHz at 44 dB.
 - b. 100 MHz at 44 dB.
 - c. 10 MHz at 44 dB.
 - d. 100 MHz at 44 dB.
4. MOVs shall be thermally protected for low current faults and shall be fused with surge-rated fuses. The surge-rated surge current passes and clears the circuit safely if the surge capacity is exceeded. Enhanced diagnostics shall continuously monitor the unit's status and shall include LEDs to signal a reduction in surge capacity or the loss of a suppression circuit. An audible alarm, with test and silence features, shall be furnished in diagnostic package.
5. Each phase or the entire unit shall be replaceable and have bolted-on, tin-plated copper connections. Unit to have UL witnessed fault current rating of 65,000 symmetrical amperes.
6. Surge suppression units shall comply with the following:
 - a. UL certified.
 - b. UL 1283.

- c. UL 1449.
- d. IEEE C 62.45.
- e. IEEE C 62.41.

- f. Nationally Recognized Testing Laboratory (NRTL) or equal.

C. Panelboard Cabinets:

1. Panelboard cabinets shall be code gage galvanized steel or blue steel; fronts, doors, and trims shall be code gage furniture steel. Cabinets shall be furnished with at least six-inch high gutters at top and bottom where feeder cable size exceeds four gage or where feeder cable passes through cabinet vertically. Cabinets shall be furnished with top and bottom gutters sized as required by inspection department having jurisdiction, but never less than six inches where more than one feeder enters top or bottom of cabinets. Side gutters shall not be less than four inches wide. Width of cabinets shall be 20 inches, unless otherwise indicated on Drawings.
2. Doors shall be cut true, shall accurately fit opening and finish smooth across joints. Rabbets shall be inside. Hinges shall be entirely concealed except for barrels and pins. Hinge flanges shall be welded to door and trim. Doors shall be equipped with flush type, spring-latching, Corbin locks for metal doors, keyed to Corbin No. 60 keys.
3. Where contactors, time switches, and control devices are specified or indicated to be installed within panelboard cabinets, a separate compartment and door shall be provided at top of cabinet for such devices. Door shall be sized as required to permit removal of contactor and other devices intact. Gutters shall be provided at sides and top of compartment. Doors shall be equipped with flush type, spring-latching, Corbin locks for metal doors keyed to Corbin No. 60 keys.
4. Provide and install panelboard manufacturer's permanent circuit number kit option.
5. Panelboards with control devices in compartment shall arrive at the Project site completely assembled with control devices installed and wired.
6. Outdoor cabinets shall be NEMA Type 3R. Construction shall be formed from code gage galvanized steel with ANSI No. 61 gray enamel finish. Provide heavy-duty, three point latching, vault type door handles with padlocking provisions. Provide stainless steel or galvanized butt hinges on doors. Padlocks shall be furnished, keyed to Corbin No. 60 keys.

7. Self-tapping screws and bolts not permitted.

- D. Panelboard Schedule: Provide a neatly typewritten schedule with number or name of room or area, or load served by each panelboard circuit. Room numbers or names shall be determined at the Project site and shall not necessarily be those indicated on the Drawings. Schedule shall also indicate panel designation, voltage and phase, building and distribution panel or switchboard from which it is fed. Schedule shall

be installed in a frame under transparent plastic 1/32 inch thick on inside of each panelboard cabinet door.

- E. Panelboard nameplate: Provide a nameplate identifying panelboard. Plates shall be black and white plastic nameplate stock, with character cut through black exposing white and shall bare designation of service. Name plate shall be mechanically fastened to switchboard.

- F. Provide additional labeling on dead-front of panelboard. Label shall be a P-Touch or equal with a minimum width of 3/8 inch with black letters on white background. Label shall re-identify panelboard and also identify name and location of power source feeding this panel. Location information shall include building name if located in different building and name or room location. If power source is installed in same room, label should indicate source name and "In this Room"

- G. Panelboard Standards: Panelboards shall be UL, or other NRTL listed and labeled. Panelboards shall meet latest revisions of following standards:

1. California Electric Code, Article 384.
2. UL 67, Panelboards.
3. UL 50, Cabinets and Boxes.
4. UL 943, GFCI.
5. UL 489, Molded Case Circuit Breakers.
6. NEMA PB1.
7. Federal Specifications W-P- 115C and WC-375B.

- H. Signal Terminal Cabinets:

1. Signal terminal cabinets shall conform to the Specifications for panelboard cabinets, except as modified herein.

2. Terminal cabinets shall be flush type, with two-inch trim or surface mounted type, as indicated on Drawings. Terminal cabinets shall be furnished with sections and barriers to separate each system. Sections over 24 inches in width shall be provided with double doors and locks. Terminal cabinets, or sections of terminals housing separate systems, shall measure 12 inches long by 18 inches high by 5 ¾-inch deep, unless otherwise indicated on Drawings. Trims for sectional cabinets shall be of one-piece construction.
3. Terminal cabinets shall be furnished with ¾ inch thick plywood. Plywood shall be fastened in place with machine screws or factory installed mounting screws.
4. Flush-mounted terminal cabinets shall be finished as specified for flush-mounted panelboard cabinets. Surface and semi-flush mounted terminal cabinets shall be finished as specified for surface-mounted panelboard cabinets.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Panelboards shall be manufactured by Siemens, General Electric, Cutler Hammer, Square D or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Panelboards shall be located so they are readily accessible and not exposed to physical damage.
- B. Panelboards installed outdoors shall be specifically listed for wet locations and shall be weatherproof in NEMA Type 3R cabinets.
- C. Panelboard locations shall provide sufficient working space around panels to comply with the California Electrical Code.
- D. Panelboards shall be securely fastened to structure and mounted on surface by at least four points.

- E. Unused openings in cabinets shall be effectively closed as required by the manufacturer.
 - F. Cabinets shall be grounded as specified in Article 250 of the California Electrical Code.
 - G. Conduits shall be installed so as to prevent moisture or water from entering and accumulating within the enclosure.
 - H. Lugs shall be suitable and listed for installation with the conductor being connected.
 - I. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
 - J. Maintain the required bending radius of conductors inside the cabinet.
 - K. Clean the cabinet of foreign material such as cement, plaster, and paint.
 - L. Distribute and arrange conductors neatly in the wiring gutters.
 - M. Use the manufacturer's torque values to tighten lugs.
 - N. Before energizing panelboards, the following steps shall be taken:
 - 1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been provided.
 - 2. Remove shipping blocks from component devices and panelboard interiors.
 - 3. Manually exercise circuit breakers to verify they operate freely.
 - 4. Remove debris from panelboard interior.
 - O. Follow manufacturer's instructions for installation.
 - P. Do not install in highly corrosive environments, unless rated for the application.
- 3.02 PROTECTION
- A. Protect the Work of this section until Substantial Completion.
- 3.03 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 26 27 26 WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Receptacles, switches, dimmers, floor outlets, wall box occupancy sensors and other wiring devices.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Each device indicating FS number, amperage and voltage rating, materials, color and manufacturer's catalog sheet.
 - 2. Each device plate indicating materials and thickness or gauge of materials, color and manufacturer's catalog sheet.
 - 3. All switches and receptacles shall be of same manufacturer.
 - 4. Occupancy and daylight sensors layout drawings and sensor certification by California Energy Commission.

1.3 PRODUCTS

A. GENERAL

- 1. All devices shall conform to NEMA standards, shall be UL listed and labeled, and shall be "Specification Grade," meeting the requirements of FS WC-596-F and switches meeting the requirements of FS WS-896-E.

B. SWITCHES

- 1. Wall switches shall be fully enclosed, quiet type tumbler switches rated 20 amperes, 120 or 277-volt, nylon or composition.
- 2. Quiet switches, 20 ampere type, may be used in quiet locations at full rating for inductive or non-inductive loads and incandescent or fluorescent lighting loads.
- 3. Single Pole Quiet Switches.
- 4. Double Pole Quiet Switches.
- 5. Three-way Quiet Switches. Four-way quiet switches.
- 6. Control switches for lighting shall be 3-way, normally open, momentary contact, tumbler switches. The switch shall be wired so that the lights shall be "ON" when the switch is moved to the "UP" position.
- 7. Remote control motor switches shall be standard duty, momentary contact, push button, or selector switches, with pilot lights and jewels.
- 8. Switches in outdoor locations shall have weatherproof plates.
- 9. Manual motor control switches for single-phase motors shall be flush or surface mounted, as required, full-voltage type with thermal overload protection and with pilot light and jewel where specified.
- 10. Contactors for the control of lighting circuits shall be mechanically held, NEMA Size 2 or larger, with the number of poles as required by the

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schedules or diagrams. Contactors shall have coil clearing contacts.

C. RECEPTACLES

1. Single and duplex convenience receptacles shall be U-grounded type, 125 volts, side and back wired with binding screws only. Rating 15 or 20 amperes as indicated.
2. The grounding contact shall be internally connected to the frame with ground terminal for external ground.
3. Special receptacles shall be as indicated on Drawings by NEMA configuration.
4. Ground fault receptacles, self-testing type, shall be 20 amperes, 125 volt, duplex, three wire grounding with pilot lights and test and reset buttons, suitable for self-testing type, suitable for feed-through, color to be as selected by County's Representative from manufacturer's standard colors.
5. Corridor Cleaning Receptacles shall be 20 ampere.
6. Wiring devices in exposed weatherproof boxes shall be the devices specified in this Section, and shall be installed in "FS" or "FD" series condulets with weatherproof cast metal covers, and gaskets as required.
7. Isolated-Ground, Duplex Convenience Receptacles, 125V, 20A, comply with NEMA WD 1, NEMA WD6, configuration 5-20R, and UL 498. Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
8. All receptacles shall have matching plates.

D. FLOOR OUTLETS

1. Where floor outlets are shown, boxes and covers as specified in Section 26 0533, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS. Receptacles shall be as specified in this section.
2. Where 120, 208, or 240 volts are used, standard NEMA receptacles, suitable for the service, shall be used. Receptacles shall be Hubbell, or equal, with ampere and voltage ratings as required.

E. PLATES

1. Furnish plates for all switches, occupancy sensors, daylight sensors, photocells, receptacles, junction boxes, telephone and other outlets.
2. Furnish labeled plates for all lock switches, pilot switches, switches from which equipment or circuit controlled cannot be readily seen, three or more switches under a common plate and for switches as indicated, and for each receptacle and switch, indicating panel and circuit number.
3. Where outlets are indicated to be weatherproof, furnish a AISI Type 302 stainless with double hinged covers.
4. Furnish plates equipped with close fitting openings for the exact device to be used.

F. SENSORS

1. General

- a. One year manufacturer's warranty.
 - b. Coordinate exact locations of sensors with all trades, and submit plans indicating sensor locations and coverages, confirmed by sensor manufacturer, for review by County's Representative.
 - c. Furnish occupancy sensors, including switch power packs, control/units, relays, to suit function of rooms.
2. Occupancy Sensors
- a. Furnish California Energy Commission approved, UL listed, dual-technology, (passive infrared and ultrasonic) occupancy sensors in individual rooms, at locations indicated on drawings, with no interference with hearing aid devices. Locate sensors in locations recommended by manufacturer, and as approved by County's Representative. Each sensor shall be furnished with switch/power pack.
 - b. Wall Sensor.
 - 1) Automatic on-off control of lighting loads in rooms as indicated, rated for both incandescent and fluorescent lighting. Maximum load of 600 VA at 120V and up to 1200 VA at 277V with Adaptive Technology, with zero print switching, capable of switching electronic fluorescent ballasts which are to be installed.
 - 2) Area covered – minimum 800 square feet with 9 foot ceiling.
 - 3) Two position switch; automatic mode, and override of the automatic mode to turn lights off even if room is occupied.
 - 4) Delayed automatic "off" (time-out) adjustable from minimum of 1 minute to a maximum of 20 minutes. Movement in the room during the time-out period to reset the time delay.
 - 5) An ambient light override that may be set so that when sufficient ambient light (daylight) is present, the lighting shall not turn on. Adjustable from full daylight to less than 40 foot candles. Built-in photocell with normal super-saver mode for daylight.
 - 6) Ivory (unless otherwise noted) injection molded thermoplastic device body for mounting on a single gang plaster ring, with panel and circuit number.
 - 7) Sensor with bi-level switches where indicated on Drawings.
 - 8) Sensor to have adaptive technology that continuously analyses occupancy patterns, and adjusts the time and sensitivity providing a setting to ensure that sensor is providing a zone maintenance-free sensor.
3. Ceiling Sensor
- a. Automatic on-off control of lighting loads in rooms as indicated. Unit complete with low voltage power supply, relay for switching multiple circuits with local manual switches, single or multiple sensors as indicated on drawings.
 - b. Each sensor to have a field of range minimum of 1000 square feet area. Multiple sensors to double the range.
 - c. Sensor to have on-auto switch, adjustable time delay between 1-20 minutes, adjustable sensitivity and normally closed relay to leave lights "on" on sensors failure.
 - d. Housing made of rugged high impact injected molded plastic colored

white.

1.4 INSTALLATION

- A. Mount switches 4' above finished floor and vertically in all locations unless indicated otherwise. Refer to Architectural elevations.
- B. All convenience and telephone/data/CATV outlets mounted 18" above the floor shall be installed vertically. Install receptacle with the grounding terminal up. Outlets required to be located above casework counters or back splashes shall be mounted horizontally at 4" above top of counter or backsplash. Receptacles with the ground slot to the left.
- C. CEC sized (#12 minimum) bonding jumper shall connect grounded outlet box to receptacle grounding terminal on all flush mounted units.
- D. Align and plumb all devices and plates. Plates shall fit flat against wall and tight against device surface without strain on plate.
- E. Each class of device shall be furnished by one manufacturer for total Project. Mixing devices of different suppliers shall not be permitted.
- F. Coordinate exact placement of occupancy sensors with other trades, and per manufacturer's recommendations.
- G. Manual dimmers shall be installed in individual outlet boxes. Do not install in ganged boxes with other devices.
- H. Contractor shall furnish the services of the manufacturer's trained employee in adjusting the

END SECTION

SECTION 26 28 13 FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Low-voltage cartridge fuses rated 600volts AC and less.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 4. Coordination charts and tables and related data.
 - 5. Fuse sizes for elevator feeders and elevator disconnect switches.

1.3 PRODUCTS

- A. Quality Standards: NEMA FU 1 for cartridge fuses.
- B. Cartridge Fuses: Nonrenewable.
- C. Spare-Fuse Cabinet: Wall-mounted steel unit with fuse pullers for each size of fuse.
- D. Cartridge Fuses Rated 600 Volts Or Less:
 - 1. Characteristics: Nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages. Refer to Drawings for ratings.
 - a. 600 Ampere or Less: Class J, time delay.
 - b. Fuses Protecting Control Circuits: Class CC, time delay.

1.4 INSTALLATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

- C. Examine utilization equipment nameplates and installation instructions. Install
- D. fuses of sizes and with characteristics appropriate for each piece of equipment.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.
- F. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

1.5 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 26 0553 and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END SECTION

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Indoor enclosed dead-front switchboards rated 600V and below.

1.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers on emergency power systems shall withstand the effects of earthquake motions determined according to ASCE/SEI 7, Seismic Zone 4.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- B. Coordinate AIC and fuse ratings with contractor furnished Overcurrent Protective Device Coordination study.

1.3 SUBMITTALS

- A. Shop Drawings and Product Data: The following list includes the required shop drawings that shall be submitted.
 - 1. Complete equipment shop drawings for each type of enclosed switch, accessory and component indicated. Include dimensioned elevations, sections, weights and manufacturer's technical data on features, performance, electrical characteristics, ratings accessories and finishes.
- B. Seismic calculations shall be by Structural Engineer, registered in State of California, for the support of disconnect switches, and drawings, indicating intended installation.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Comply with CEC.

- D. Comply with Federal Specification W-S-865.
- E. Comply with UL 98 and NEMA KS1 for fusible and nonfusible switches.
- F. Comply with UL 489, NEMA AB1, and NEMA AB3, for enclosed molded-case circuit breakers.
- G. Comply with ASME A17.1 for shunt trip switches.
- H. Comply with Federal Specification W-S-865.

1.5 PRODUCTS

- A. All disconnect switches shall be the "Heavy Duty" type and shall meet the latest edition of FS W-S-865.
- B. Type HD heavy duty single throw 600V AC 30A unless otherwise noted on drawings, horsepower rated, lockable handle with capability to accept three padlocks and interlocked with cover in closed position.
- C. Furnish all disconnect switches with devices enabling the switch to be locked in the open and closed positions.
- D. Manual motor starters shall be motor rated tumbler switches rated 3 HP 208 or 480 volts, three-phase with overload heaters as specified or shown to protect equipment served.
- E. Externally operable safety switches shall have quick-make, quick-break mechanism, capable of switching 10 times the switch rating, and with cover interlocks with defeat mechanism for maintenance.
- F. Furnish switches with number of poles, ampere, voltage and HP rating, types of enclosures and fusible or nonfusible as indicated and as required for the particular application. Disconnect switches shall be heavy duty type unless otherwise indicated.
- G. Furnish NEMA 1 enclosures for interior locations and NEMA 3R enclosures for exterior or wet locations unless otherwise indicated. Switches having a dual rating when used with dual element fuses shall have rating so indicated on the metal plate. Fuses, where required, shall be UL listed current limiting type RK5.
- H. For disconnect between variable speed starters and the motor served, furnish auxiliary contact in switch, wired to disconnect the starter coil in OFF position. Auxiliary contact to open before disconnect.
- I. Fuses, where indicated to be used, shall be current-limiting type, with rejection type fuse holders. And fuse adaptors as needed.
- J. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted, insulated, capable of being grounded and bonded, labeled for copper neutral conductors.
3. Auxiliary Contact Kit: Two normally open/normally closed Form C auxiliary contacts arranged to activate before switch blades open.

K. Lugs: Mechanical type suitable for number and size of copper conductors indicated.

L. Enclosures:

1. Enclosed Switches and Circuit Breakers: NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - a. Indoor, Dry and Clean Locations: Type 1.
 - b. Outdoor Locations: Type 3R.

1.6 FIELD QUALITY CONTROL

A. Testing: By Contractor.

1. Visual and mechanical
 - a. Inspect for physical damage and code violations.
 - b. Ensure all nameplates and labels are correct and in place.

1.7 INSTALLATION

- A. Install switches, disconnects and safety, where indicated on the Drawings, or required by applicable code requirements.
- B. Securely fasten to structural members or channel support. In outdoors, mount on epoxy coated unistrut support, at plus 42 inches AFF. Comply with restrictions on penetrating of roofing material.
- C. Install manual motor starters flush mounted for switching motors 3 HP and smaller in finished areas.
- D. Install manual motor starters, surface mounted, in equipment rooms and nonfinished areas.
- E. Where installed above ceilings, access panels shall be furnished.

1.8 ADJUSTING

- A. Set field-adjustable circuit-breaker trip ranges.

END SECTION

SECTION 27 00 00 – COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. See Division 1 for description of work.
- B. In general, the contract documents (drawings and specifications) describe a low voltage communication system and infrastructure which includes:
 - 1. Communication Systems (27 00 00)
 - 2. Common Work Results (27 05 00)
 - 3. Grounding and Bonding for Communication Systems (27 05 26)
 - 4. Pathways for Communications Systems (27 05 28)
 - 5. Identification for Communication Systems (27 05 53)
 - 6. Communications Equipment Room Fittings (27 11 00)
 - 7. Communications Backbone Cabling (27 13 00)
 - 8. Communications Horizontal Cabling (27 15 00)
- C. It is the intent of the specifications and construction documents that the Contractor shall include all necessary items for the complete and fully-operational system. In addition to complete and fully-operational, the system must also meet the design intent with regards to special features and functionality mentioned in the specifications or drawings.
 - 1. Work or product not specifically indicated in the specifications or on the drawings, but which is required for a complete and fully-operational system as defined above, shall be provided by the Contractor at no additional cost.
 - 2. The specification of certain products in the specifications or drawings shall not be construed as a release from furnishing such additional products and materials necessary to furnish a complete and fully-operational system as defined above.
- D. Work shall be complete, certified, tested, and ready for operation.
 - 1. This includes all necessary items and labor not specified but necessary for a complete and working system.
 - 2. Contractor shall provide at his or her expense all labor, material transportation, accommodations, tool and utilities necessary for the completion of the project.
- E. Any item shown in the drawings but not in the specifications or vice versa shall be treated as though shown in both.
- F. Contractor shall be responsible for repair of any base building structure or finishes that are damaged by the installation of any work specified in this section.
- G. No cutting or patching of existing work shall be permitted without prior written consent of the owner. Request for permission to do cutting, drilling or chipping shall include

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explicit details and description of work, the proposed schedule, and shall not under any circumstances diminish the structural integrity, functional capabilities, or aesthetic appearance of the building components or systems.

- H. Except where the Architect, Engineer or Manufacturer has specifically indicated dimensions, technology drawings are diagrammatic and shall not be scaled. Visit project site, survey existing conditions, and coordinate work to comply with documents.

1.2 PROJECT CONDITIONS

- A. The contractor shall within 5 days of award, coordinate with owner and GC a visit to the site. Contractor shall be responsible for reviewing all related drawings and ensuring site conditions do not pose any conflicts with the design shown. Any clarifications needed or conflicts realized, shall be sent in writing no later than (10) days after site visit.
- B. The contractor may be performing some work in areas of the facility that are owner occupied. The contractor shall coordinate all work with the owner to occur at times necessary to minimize impact to normal operations, including after hours, night shift and weekends. The contractor shall supply all necessary materials to minimize noise, dust, and interruption to normal operations. Work done in these areas will not constitute a change order from the contractor due to scheduling conflicts, materials, or other requirements to perform the stated work.

1.3 DEFINITIONS

- A. Provide: Furnish, install and connect complete.
- B. Work: Materials completely installed.
- C. Review of shop drawings: A service by the engineer to reduce the possibility of materials being ordered which do not comply with contract documents.
- D. Engineer: Exante360
- E. Contractor: Successful bidder of these documents

1.4 ADMINISTRATION

- A. The Contractor shall attend all job progress meetings as required by the owner, General Contractor and the Engineer as soon as notice to proceed is given. The Contractor shall furnish to owner a list of his employees, all subcontractors' key personnel and the project representative.
- B. The contractor is responsible for all quantities necessary to complete the project and is urged to do a complete review.

- C. Where any conflict or discrepancy occurs within these documents, or any conflict or discrepancy occurs between these documents and any other contractual documentation, the stricter standard and greater quantity shall be deemed to apply.
- D. The contractor shall familiarize themselves with the local conditions under which the work is to performed, and its relationship to existing conditions, other trades, and any obstructions that may affect the proper execution and completion of the work. It is the contractor's responsibility to ascertain any and all conditions. Failure to understand or discover any condition that will result in a change order that increases the contract amount; that should have been discovered in the due diligence of reviewing the site and contract documents may result in denial of the change order.
- E. The Contractor shall call the attention of the Authorized Representative to any error, conflict, or discrepancy in Plans and/or Specifications. Do not proceed with any questionable items of work until a resolution or clarification has been made. Supplemental Plans and Specifications may be supplied as required and shall become part of the Contract Documents.
- F. The Contractor shall coordinate installation with other crafts employed on this project.
- G. The Contractor shall arrange work to reduce interruption on any existing service to a minimum. When interruptions are unavoidable, consult the Owner or Authorized Representative and agree to a mutually satisfactory time and duration. Submit in writing to the Authorized Representative the time and duration agreed upon.
- H. During the course the Project, any questions, notifications, requests or any other communications with the Owner or Consultant shall be in writing.

1.5 SUPPLEMENTAL BID SUBMITTAL REQUIREMENTS

- A. These requirements are meant to supplement any bidding requirements provided by the bid administrator. The purpose of the additional documentation is for bid analysis and to help the Owner and Consultant verify the bidder has a complete understanding of the construction documents. The failure of the Contractor to include in the submittal any items called for in the Contract Documents shall not in any way relieve the Contractor from the responsibility of providing said items.
- B. Submit the following additional documentation for each section (Grounding and Bonding, Cabling, Paging, Integrated Audiovisual, Distributed Communications, etc....) with the bid submittal to the Bid Administrator:
 - 1. Provide itemized pricing for all equipment. Include quantity, extended pricing, manufacturer, model, version (if applicable) and specification number. Provide in order by specification number. Connectors and miscellaneous small hardware may be listed in total.
 - 2. Total for taxes, including all applicable local, state and federal taxes.
 - 3. Total for installation, including, but not limited to, all labor, expenses, shipping, hardware, software, consumables, etc.

4. Total for Engineering, including, but not limited to, CAD, shop drawing preparation and any other labor not directly related to installation.
 5. Total cost for the required warranty as described in the Contract Documents.
- C. Submit the following additional documentation for the complete project with the bid submittal to the Bid Administrator:
1. Totals for each bid section
 2. Bid Bond and Performance Bond as required
 3. Any add/deduct alternates
- D. During any bidding period, any questions, notifications, requests or any other communications with the Consultant shall be compiled into a single document and submitted to the Consultant through the designated Bid Administrator. While the Consultant shall make a reasonable effort to respond to any questions before the bid submission deadline, the Consultant cannot guarantee such response.

1.6 SUBSTITUTION OF MATERIALS

- A. Submit base bid on equipment, products and materials specified or approved. Equipment, products and/or materials by manufacturers not specified but performing the same function will be acceptable if all of the following conditions apply:
1. Submitted for approval along with base price and alternate price for submitted items;
 2. Engineer considers the item equivalent to that specified.
 3. The substitution does not void or downgrade the manufacturer's Total Solution Warranty.
- The engineer, at their discretion, may issue an addendum to accept the item should the substitution create a situation that warrants an addendum.
- B. Contractor assumes responsibility for all changes in cabling, system components, equipment capacity or other additional changes caused by substitution of materials. The Contractor shall assume all expenses for all additional design and construction due to such substitutions.
- C. The Contractor assumes the responsibility of all costs of design and construction resulting from any modifications required to any building equipment or system due to substitution of data/voice materials.

1.7 CONTRACTOR'S COORDINATION

- A. The Contractor is responsible for overall coordination of the work.
- B. Note that contract drawings shall not be considered as fabrication or installation drawings. In some cases, they only indicate intent; they may be diagrammatic, and they may show only typical conditions; they do not indicate every item required to complete the work.

- C. Prior to the installation and connection of mechanical, electrical and technology for work of other sections, or of other contractors, verify the requirements indicated in those divisions with the requirements and characteristics of the other contractors' equipment.
 - 1. Coordinate layout of mechanical, electrical and technology work before fabrication and installation begins.
 - 2. Bring deviations and conflicts to the attention of the Project Design Team.
- D. Mechanical and electrical drawings show the general arrangement of the work. Follow as closely as actual building construction and the work of other system permit.
 - 1. Electrical drawings are diagrammatic and do not show all offsets, fittings, and accessories which may be required.
 - 2. Investigate the structure and finish conditions affecting the work and arrange the work accordingly.

1.8 COORDINATION DRAWINGS

- A. The Contractor is responsible for coordination required for use of space. BIM model can be used for clash detection.
- B. The following coordination drawing requirements shall apply only where the BIM model is not used via clash detection for use of space coordination.
- C. Prepare and submit coordination drawings where close and careful coordination is required:
 - 1. Show the interrelationship of components shown on separate shop drawings.
 - 2. Indicate required installation sequences.
 - 3. Prepare as required and submit coordination drawings for areas of the work listed below:
 - a. Where utilities cross over
 - b. Refer to the mechanical, electrical and technology divisions for specific coordination drawing requirements for mechanical and electrical installations.
 - c. Coordinate information indicating locations and elevations of the associated power, control, and data, fire protection piping, HVAC ductwork, plumbing piping, electrical and low voltage rough-in and fixtures.
 - d. Mechanical and electrical rooms.
 - e. Penetrations through fire rated walls with all mechanical, electrical, plumbing, fire protection, communications and security, and other such systems, coordinated for locations of all floor, wall, and beam penetrations, sleeves, and embeds.
- D. All other work areas where congestion might necessitate a change in the ceiling heights, lighting, and diffuser locations, structure, or finishes.

1.9 SHOP DRAWINGS AND EQUIPMENT DATA SUBMITTALS

- A. All shop drawings, change orders, and where applicable, materials must be reviewed by engineer and/or owner and approved in writing prior to start of construction. The engineer's review shall not relieve the Contractor of responsibility for dimensions or

compliance with the contract documents. The reviewer's failure to detect an error does not constitute permission for the Contractor to proceed in error. Any change orders must be approved by owner in writing prior to start of the change order work. Any work performed by Contractor, not directed in writing by owner, will result in Contractor removing all materials installed by Contractor that were not approved in writing at the Contractor's cost.

- B. Submit at one time within 14 days of contract awarding, drawings and product data on all equipment. This includes all equipment for all specification sections. Provide submittals in 3-ring binder and hard copy, separated by tabs between each spec section and organizing equipment in the order it appears in each spec section. Check for compliance with contract documents. No substitutions to be submitted on without prior written acceptance by engineer.
- C. Support all submittals with descriptive materials, i.e., catalog sheets, product data sheets, diagrams, performance curves, and charts published by the manufacturer. These materials shall show conformance to specification and drawing requirements. Model view shall contain all information to indicate compliance with equipment specified.
- D. Where multiple products are listed on a single cut-sheet, ensure each piece of equipment (including size and color type) being submitted on is clearly identified on each page with an arrow, circle, or some other method that allows for documents to be scanned while still being able to identify equipment being submitted on.
- E. Where applicable; provide all inter-equipment wiring diagrams and drawings necessary to install the equipment being supplied. These drawings will show all wiring by wire gauge, conductors, and wire manufacturer. These drawings must be updated prior to completion of any work to reflect changes that may have been made during actual installation.
- F. After the award of contract, the Contractor shall prepare a detailed schedule using "Microsoft Project" software or equivalent. It shall be prepared in the time scaled precedence diagram format. The Contractor Project Schedule (CPS) shall indicate detailed activities for the projected life of the project. The CPS shall consist of detailed activities and their restraining relationships for all sections as outlined in the specifications. All related work shall be performed by a single contractor. It will also detail manpower usage throughout the project. Provide an updated schedule each week, noting any changes that impact overall project schedule. Include the following key milestones start dates and durations for each system in Division 27:
 - 1. Pre-construction meetings
 - 2. Site Mobilization
 - 3. Material delivery
 - 4. Telecommunications Equipment/Data Room build-outs
 - 5. Copper backbone installation
 - 6. Fiber backbone installation
 - 7. Structured cabling installation (by floor/area)
 - 8. Structured cabling termination

9. System installation (name each system in Division 27 and breakout by floor/area)
10. Testing and commissioning (by system and by floor/area)

1.10 SAMPLES

- A. The owner/specifying authority reserves the right to request one each, samples of terminal (station) equipment for the purpose of coordinating colors, aesthetics, trim plate sizing, etc. These samples would be supplied at no-cost to the owner by awarded contractor.

1.11 REFERENCE STANDARDS

- A. In addition to those referenced in Division 1, all work shall conform to the following standards and codes (most current edition, revisions, and addenda), where applicable. When a conflict occurs, follow the most stringent requirements:
 1. National Fire Protection Association
 - a. NFPA 70
 - b. National Electrical Code
 2. Electronic Industries Association (EIA)
 3. Telecommunication Industry Association (TIA)
Including, but not limited to:
 - a. TIA 568
 - b. TIA 569
 - c. TIA 598
 - d. TIA 606
 - e. TIA 607
 - f. TIA 758
 4. American National Standard Institute (ANSI)
 5. American Society for Testing and Materials (ASTM)
 6. Underwriters Laboratories, Inc. (UL)
 - a. UL 1069
 7. BICSI
 - a. Telecommunication Distribution Methods Manual
 - b. Information Transport Systems Installation Manual
 - c. Customer-Owned Outside Plant Manual
 - d. Network Design Reference Manual
 8. Local, state and federal regulations
- B. If any portion of the Contract Documents is observed by the Contractor to be in variance with said laws, ordinances and regulations, the Contractor shall notify the Owner immediately and shall not proceed until changes required for compliance with said laws, regulations and ordinances have been effected.

- C. The Contractor bears full responsibility for any work performed contrary to said laws, regulations and ordinances and shall fully indemnify Owner against loss and bear all costs and penalties arising there from.

1.12 CODES AND PERMITS

- A. Provide all necessary permits and schedule all inspections in a timely manner, so that all specified systems are ready for operation on a date directed by the Owner.

PART 2 – PRODUCTS

2.1 GENERAL

- A. The use of a manufacturer's name and model or catalog number herein is for the purpose of establishing the product set, which the Contractor is to supply and install.
- B. Quantities are to be determined by Contractor unless specified.
- C. Products shall be UL listed for the purpose they are to be used.

PART 3 – EXECUTION

3.1 GENERAL

- A. Before installation of cabling and/or equipment, the contractor shall field-investigate the facility and ascertain if physical and electrical conditions within the contractor's work are present.
- B. Any discrepancies, questions or concerns noted at that time should be brought to the immediate attention of the Owner or Engineer.

3.2 USE OF SITE

- A. Use of site shall be at the General Contractor direction. Building access shall be directed by the General Contractor.
- B. Coordinate with the General Contractor for lay-down areas for material storage and administrative work areas.
- C. Contractor shall coordinate with the General Contractor and their subs-contractors whether or not the Contractor's contract is with the General Contractor or not.
- D. Contractor shall be required to follow all General Contractor safety rules and regulations and shall be held responsible for violation of said rules and regulations.

3.3 PROJECT RECORD DOCUMENTS (AS BUILTS)

- A. Throughout progress of the Work, maintain an accurate record of changes in Contract Documents. Upon completion of Work, transfer recorded changes to a set of Project Record Documents. Project Record Documents shall include As-Built drawings in electronic format (Autodesk Revit BIM and PDF).
- B. The attached communication drawings shall be marked in pen during the course of the project to include but not limited to the following:
 - 1. Cable routing
 - 2. Conduit locations
 - 3. Cable labeling number
 - 4. Penetration locations, quantities, sizes
 - 5. Coordinate all as-built requirements with Designer and Owner.
- C. Submit Project Record Documents to the engineer.

3.4 PROJECT CLOSE-OUT

- A. Prior to final inspection and acceptance of the work, remove all debris, rubbish, waste material, tools, construction equipment, machinery and surplus materials from the project site and thoroughly clean your work area.
- B. Before the Project Closeout date, the Contractor shall submit:
 - 1. Operation and Maintenance Data.
 - 2. Certification and Warranties.
 - 3. Deliver evidence of compliance with requirements of governing authorities.
 - 4. Certificates of Inspection:
 - a. Low Voltage
 - b. Test Data Reports. Deliver test data in electronic format.
 - c. Service Contracts.
 - d. Project Record Documents.
- C. Project Closeout: Contractor shall submit written notice that:
 - 1. Contract Documents have been reviewed.
 - 2. Project has been inspected for compliance with Contract.
 - 3. Work has been completed in accordance with the Contract.
- D. The Engineer will make final inspection after receipt of notice.

END OF SECTION

SECTION 27 05 00 – COMMON WORK RESULTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section specifies the basic requirements for communications installations as indicated or required and includes requirements common to more than one specification section of this division (such as related documents, related sections, definitions, governing requirements, contractor requirements, warranty requirements, submittal requirements/procedures, and project closeout requirements/procedures, as well as other requirements). This section may expand upon and/or supplement the requirements specified in Division 01.
- B. Structured Cabling System (SCS) to support all low-voltage systems including: data networking and video surveillance systems.
- C. Horizontal Cabling
 - 1. Furnish and install plenum-rated Category 6, 4-pair UTP cables for all horizontal voice and data links from the cross-connect in the Telecommunications Data Room (TDR) or Telecommunications Equipment Room (TEC) to each telecommunications outlet and provide quantities as shown on drawings.
 - 2. The maximum horizontal cable distance from the telecommunications outlet to the horizontal cross-connect within the telecommunications rooms shall be 295 feet.
 - 3. All horizontal cables shall be routed through an approved pathway such as basket tray, J-hooks, conduits, sleeves, EZ Path, speed sleeve, or furniture pathway.
- D. Telecommunication outlets
 - 1. All telecommunications outlets shall consist of 8-position, 8-wire modular RJ-45 Category 6 jack(s) as noted locations on drawings. Drawings note the quantity to provide at the outlet.
 - 2. Terminate all horizontal voice/data cables per the TIA/EIA 568B wiring scheme unless otherwise noted.
- E. Telecommunications Rooms
 - 1. The primary function of the Telecommunications Rooms is the location of technology systems, equipment and the distribution of copper horizontal cables and termination of copper and fiber backbone cables.
 - 2. Furnish and install equipment racks as shown on drawings. Field verify locations and requirements with the Technology Designer, Architect/Engineer and Owner prior to installation.
 - 3. Telecommunications Rooms shall be built and provisioned according to the requirements in TIA/EIA Standard 569B and the general provisions of the Contract,

including General, Supplementary and other conditions, and the requirements of other Divisions apply to the work of this Division.

F. Other Systems Cabling.

1. Furnish and install cabling to support video surveillance as called out in the specifications and drawings.

1.2 RELATED DOCUMENTS

- A. The general provisions of the Contract, including General, Supplementary, and other conditions, and the requirements of other Divisions apply to the work of this Division.
- B. Examine the Contract Documents in their entirety (including Drawings and Specification Sections in the other Divisions) for requirements or work, which may affect work under this Section, regardless of whether such requirements or work are specifically indicated in this Section.

1.3 SCOPE OF WORK

- A. The work covered under this section of the specifications consists of furnishing all labor, equipment, supplies and materials, tools, services and facilities in performing all operations, including installation of wire and cable, telecommunication outlets, and all other functions necessary for the complete installation of a structured cabling system supporting data networking, telecommunications, integrated audiovisual, video surveillance and access control systems in accordance with the specifications and drawings, except as specifically noted otherwise.
- B. The Cable Contractor shall coordinate with other trades and vendors prior to the start of work.
- C. The work of this section shall include, but not be limited to furnishing and installation of the following:
 1. Category 6 unshielded twisted-pair horizontal cables.
 2. Singlemode and multimode fiber optic backbone cables.
 3. Telecommunications outlets/connectors and faceplates.
 4. Build out of TDR/TEC rooms.
 5. Basket tray, ladder rack, and J-hooks including all necessary support hardware and fittings.
 6. Firestopping systems.
 7. Grounding and bonding.
 8. Video surveillance cable.
 9. Fire stopping of telecommunications pathways that penetrate fire-rate wall, floors, and ceiling.
 10. Category 6 UTP patch cables for voice/data cross-connects in telecommunications rooms and at device locations.

11. Category 6 patch cables for security cross-connects in telecommunications rooms.
12. Multimode and single mode fiber optic jumper cables.
13. All materials necessary for complete and proper cable management.

1.4 REVIEW OF CONTRACT DOCUMENTS

- A. The Contractor shall carefully study the Contract Documents and report to the consultant and project manager any error, inconsistency, or omission they may discover. If contractor performs any construction activity knowing it involves a recognized error, inconsistency, or omission in the Contract Documents without such notice to the consultant or project manager, the contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the attributable cost for correction.
- B. The Contractor must verify all dimensions locating the work and its relation to any existing work, all existing conditions and their relation to the work, and all man-made obstructions and conditions, etc., affecting the completion and proper execution of the work as indicated by the Contract Documents.

1.5 EXAMINATION OF THE PREMISES

- A. The Contractor shall visit the site to familiarize themselves with the local conditions under which the work is to be performed and correlate observations with the requirements of the Contract Documents. No allowance will be made for claims of concealed conditions which contractor, in exercise of reasonable diligence in the observation of the site and the review of the local conditions under which the work is to be performed, has learned, or should have learned, unless otherwise specifically agreed by owner and consultant in writing.
- B. Before ordering any materials or performing any work, the contractor shall verify all measurements. No extra charge or compensation will be allowed for duplicate work or material required because of an unverified difference between an actual dimension and the measurement indicated in the drawings. Any discrepancies shall be submitted in writing to the Project Manager and Consultant for consideration before proceeding with the work.

1.6 RELATED SECTIONS

- A. All Division 27 Specification Sections in this Bid Package
- B. The applicable portions of the Governing Requirements (see "Part 1 - General: 1.08 Governing Requirements," herein) shall be incorporated by reference into each related Specification Section.
- C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections, apply to this Section.

- D. Division 26 – Electrical.
- E. Division 28 - Electronic Safety and Security.

1.7 COMMUNICATIONS CABLING SYSTEMS

- A. The following communications systems are included within this Division:
 - 1. Communications Cabling System: Includes (but is not limited to) copper and fiber cables, patch cables, stations and station connectors, termination blocks, splices and splice enclosures, protectors, patch panels, rack and distribution equipment, equipment required for the build-out of telecommunications rooms and spaces, and other incidental and miscellaneous product and labor as required.
 - 2. New products installed shall meet the requirements of the Owner's Information Technology.

1.8 INTENT AND INTERPRETATIONS

- A. It is the intent of the Construction Documents that the Contractor shall include all items necessary for the proper execution and completion of the Work by the Contractor, resulting in complete and fully operational system(s) ready for the Owner's use, in full compliance with all applicable standards, codes, and ordinances.
 - 1. Work or product not specifically indicated in the Construction Documents, but which is necessary to result in complete and fully operational system(s) ready for the Owner's use, shall be provided by the Contractor.
 - 2. The specification of certain products in the Construction Documents shall not be construed as a release from furnishing such additional products and materials necessary to furnish complete and fully operational system(s) ready for the Owner's use.
- B. In the event that discrepancies exist or required items or details have been omitted in the Construction Documents, the Contractor shall notify the Engineer in writing a minimum (10) working days prior to the bid date. Failure to do so shall be construed as willingness to provide a complete and fully operational system within the amount bid by the Contractor. Where such discrepancies are not brought to the attention of the Engineer, the most stringent requirements shall be construed to be the basis for the Contractor's bid.
- C. Prior to bidding the project, the Contractor shall visit the site to determine all existing conditions affecting the work, the type of construction to be used, and the nature and extent of work provided by other trades. Failure to do so shall be construed as willingness to provide complete and fully operational system(s) within the amount bid by the Contractor. Site visit to be coordinated with owner/general contractor.
- D. Drawings and Specifications are complementary. Items required by either are binding as though both require them. In the event of conflict between the requirements of the Drawings and the Specifications:

1. With regards to the preparation of proposals and/or bids, the Contractor shall assume the more stringent (costly) condition shall prevail. The Contractor shall notify the Engineer of such discrepancy a minimum ten (10) working days prior to the bid date.
 2. With regards to actual construction, the Contractor shall notify the Engineer and await the Engineer's instruction prior to proceeding with procurement and installation.
 3. The drawings are diagrammatic unless detailed dimensions are included. Drawings show close approximate locations of equipment and devices. Exact locations are subject to the approval of Owner and Owner's representative.
 4. Anything mentioned in the specifications and not shown in the drawings, or shown in the drawings and not mentioned in the specifications, shall be of like effect as if shown and mentioned in both. In case of differences between the specifications and drawings, the stricter provision, as determined by the project coordinator, shall govern. Omissions from the drawings or specifications, or the incorrect description of details of work, which are evidently necessary to carry out the intent of the drawings and specifications, shall not relieve the contractor from performing such work.
- E. The Construction Documents include certain conventions in the use of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions include:
1. Abbreviated Language: Language used may be abbreviated. Implied words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpreted as the sense requires. Singular words shall be interpreted as plural and plural words interpreted as singular where applicable and where the full context so dictates.
 2. Imperative and Streamlined Language: Imperative and streamlined language is used generally. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the text, for clarity, subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or by others when so noted.
 3. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where abbreviations and acronyms are used, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context.
 4. Unless otherwise stated, words which have well known technical or construction industry meanings are used in accordance with such recognized meanings.
 5. The terms "directed," "required," "permitted," "ordered," "designated," or "prescribed," as well as similar words shall mean the direction, requirement, permission, order, designation, or prescription of the Engineer.
 6. The terms "approved," "acceptable," "satisfactory," and similar words shall mean approved by, acceptable, or satisfactory to the Engineer.
 7. The terms "necessary," "reasonable," "proper," "correct" and similar words shall mean necessary, reasonable, proper, or correct in the judgment of the Engineer.

1.9 ASSIGNMENT OF SPECIALISTS

- A. The individual Specification Sections may require that certain specific construction activities be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and such assignments are requirements over which the Contractor has no choice or option. Nevertheless, the ultimate responsibility for fulfilling the contract requirements shall remain with the Contractor.
- B. This requirement shall not be interpreted to conflict with the enforcement of local building codes and similar regulations governing the work.
- C. Drawings:
 - 1. Drawings are diagrammatic and approximate in character, are not intended to show all features of required work, and do not necessarily indicate every required component.
 - 2. Symbols used on the Drawings are defined in the legend on the Drawings. Symbols indicated on the legend may not necessarily be required.

1.10 DEFINITIONS

- A. The definitions below are applicable to the Division 27 specifications. These definitions expand upon and/or supplement the definitions specified in Division 01. In the event of discrepancies between these definitions and those defined in Division 01, the definitions in Division 1 shall take precedence.
- B. Accepted/Acceptable: Work or materials conforming with the intent of the project, and in general, conforming to the pertinent information in the Construction Documents.
- C. Approved/Approval: The written approval of the Engineer.
- D. Accessible: Easy access. Access attained without requiring extensive removal of other materials to gain access.
- E. Accessible Ceiling: Acoustical tile hanging ceilings ("Hard-lid" ceilings [concealed spine or sheetrock/gypsum ceilings], even when provided with access panels, are not considered an Accessible Ceiling.)
- F. Agreement: The contractual agreement between the Owner and the Contractor.
- G. As Called for: Materials, equipment including the execution specified/shown in the contract documents.
- H. Cable Contractor: Contractor furnishing and installing telecommunications, security, or other cable called out as part of the specifications and drawings. May also be referred to as TC (telecommunications contractor).
- I. Code Requirements: Follow minimum code requirements.

- J. Communications Infrastructure System: A Communications Cabling System (see Communications Systems, herein) combined with a Communications Raceway System (see Communications Systems, herein).
- K. Concealed: Hidden from sight in interstitial building spaces, chases, furred spaces, shafts, crawl spaces, etc.
- L. Construction Documents: Collective term for the entire set of bound or unbound material describing the construction and services required, including all Drawings, Specifications, addenda issued prior to execution of the contract, and modifications issued after execution of the Contract (such as change orders, construction change directives, supplemental instructions, etc.).
- M. Contract Documents: The Agreement (including other documents listed in the Agreement), Conditions of the Contract (General, Supplementary, and other conditions), and the Construction Documents.
- N. The Contract: The Contract Documents form the Contract. The Contract represents the entire and integrated agreement between the Owner and the Contractor and supersedes any prior negotiations, representations, or agreements, either written or oral. The Contract shall not be construed to create a contractual relationship of any kind (1) between the Engineer and the Contractor, (2) between the Owner and a Subcontractor, or (3) between any persons or entities other than the Owner and Contractor.
- O. Contractor: The party responsible for providing the system(s) as indicated herein.
- P. Drawings: The graphic and pictorial portions of the Contract Documents, wherever located and whenever issued, showing the design, location, and dimensions of the Work, generally including (but not limited to) plans, elevations, sections, details, schedules and/or diagrams.
- Q. EC: Electrical Contractor.
- R. Engineer/Consultant: The party responsible for producing the communications system(s) Construction Documents.
- S. Equal/Equivalent: Equally acceptable as determined by Owner's Representative.
- T. Existing: Equipment, device, and material present in an installation location prior to new work.
- U. Exposed: Not concealed (see above) and not installed underground.
- V. Final Completion: The date when the Engineer confirms in writing that the Contractor has completed the work in accordance with the Construction Documents, including completion of all punch list items, cleanup work and delivery of all required guarantees, warranties, licenses, releases, and other required deliverables.

- W. Furnish: To purchase, supply, and deliver to the project materials in new and operable condition, ready for installation.
- X. Governing Requirements: Collective term for regulations, laws, ordinances, codes, rules, standards, requirements, and guidelines that govern the installation and inspection of the work defined in the Contract Documents. See "Part 1 – General, 1.8 Governing Requirements" herein.
- Y. Governing Authorities: Entities or their representatives charged with formation and/or enforcement of Governing Requirements, such as the Authority Having Jurisdiction (AHJ).
- Z. Install: To place in final position in fully operable, tested condition.
- AA. Inside Plant (ISP): Infrastructure within a building.
- BB. Or Equal: Materials approved for use by the Engineer and which are dimensionally suitable and operationally identical to the specified item.
- CC. Owner: The Owner and the Owner's designated representative(s).
- DD. The Project: The total construction of which the Work performed under the Contract Documents may be the whole or a part, and which may include construction by the Owner and/or separate contractors.
- EE. Provide: To furnish and install, complete, tested and ready for intended use.
- FF. Substantial Completion: The date when all work required by the Construction Documents shall be complete (subject to the final punch list to be prepared by the Engineer) and on which the applicable jurisdictional authorities have issued a temporary certification of occupancy.
- GG. Section: An individual section of the Specifications.
- HH. Shown on Drawings: Noted, indicated, scheduled, detailed, or any other written reference made on the Drawings.
- II. Specifications: The portion of the Contract Documents consisting of the written requirements for materials, equipment, construction systems, standards and workmanship for the Work and performance of related services.
- JJ. Specification Section(s): One or more sections of the Specifications.
- KK. Section(s): An abbreviated form of Specification Section(s).
- LL. Structured Cabling System (SCS): Alternative term for Communications Cabling System
- MM. The Work: The construction and services required by the Contract Documents, whether completed or partially completed, and all other labor, materials, equipment, and services

provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

1.11 ABBREVIATIONS

- A. Refer to the individual Specification Sections and Drawings for abbreviations and their definitions.

1.12 GOVERNING REQUIREMENTS

- A. All work shall be executed in compliance with the latest version and applicable portions of the codes, regulations, standards, guidelines, and/or recommendations of the following (hereinafter referred to as Governing Requirements):

- B. General:

1. ACI: American Concrete Institute (www.aci-int.org)
2. AHJ: Authority Having Jurisdiction
3. ANSI: American National Standards Institute (www.ansi.org)
4. ASTM: American Society for Testing and Materials (www.astm.org)
5. BICSI: A Telecommunications Association (www.bicsi.org)
6. IBC: International Building Code
7. ICEA: Insulated Cable Engineers Association (www.icea.net)
8. IEEE: Institute of Electrical and Electronic Engineers (www.ieee.org, standards.ieee.org)
9. IES: Illuminating Engineering Society of North America (www.iesna.org)
10. FCC: Federal Communications Commission Rules and Regulations
11. NAB: National Association of Broadcasters
12. NFPA: National Fire Protection Association (www.nfpa.org)
13. NEC: National Electrical Code (NFPA Article 70) (www.nfpa.org, www.necdirect.org)
14. NESC: National Electrical Safety Code (<http://standards.ieee.org/nesc/>)
15. NEMA: National Electrical Manufacturers Association (www.nema.org)
16. OSHA: Occupational Safety and Health Administration (www.osha.gov)
17. RUS: Rural Utilities Service (<http://www.usda.gov/rus/>)
18. TIA/EIA: Telecommunications Industry Association/Electronics Industries Alliance (www.tiaonline.org, www.eia.org)
19. UBC: Uniform Building Code
20. UFC: Uniform Fire Code (www.nfpa.org)
21. UL: Underwriters Laboratories, Inc. (www.ul.com, ulstandardsinfo.net.ul.com)
22. State and local codes, ordinances, and regulations
23. Requirements and guidelines of local utility companies
24. Applicable state, local and/or federal specifications
25. Manufacturer installation guidelines and recommendations

- C. Communications Specific:
1. ANSI/TIA-568-C: Commercial Building Telecommunications Cabling Standard
 2. ANSI/TIA-569-C: Commercial Building Standard for Telecommunications Pathways and Spaces
 3. ANSI/TIA-606-B: Administration Standard for Commercial Telecommunications Infrastructure
 4. ANSI/TIA-607-C: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 5. ANSI/TIA-758-B: Customer-owned Outside Plant Telecommunications Infrastructure Standard
 6. TIA-942: Telecommunications Infrastructure Standard for Data Centers
 7. TIA: Technical Service Bulletins (TSBs) (related to the above TIA standards)
 8. IEEE 802.3: Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit and 802.3ae 10 Gigabit Ethernet Standard
 9. IEEE 802.11: Wireless Local Area Network Standard, including the IEEE 802.11a, 802.11b, 802.11g, and 802.11n standards
 10. BICSI: BICSI Customer Owned Outside Plant Design Manual
 11. BICSI: BICSI LAN and Internetworking Design Manual
 12. BICSI: BICSI Telecommunications Distribution Methods Manual
 13. BICSI: BICSI Telecommunications Cabling Installation Manual
 14. NEC: NFPA 70
 15. NFPA 75: Protection of Electronic Computer and Data Processing Equipment
 16. NFPA 78: Lightning Protection Code
 17. California Title 24
 18. FCC Part 68: Connection of Terminal Equipment to Telephone Network.
 19. FCC Part 76.611: CFR Title 47 Radiation Leakage Standards
- D. Work shall comply with the Governing Requirements in effect at the time of construction, including all addenda, errata, annexes, and technical service bulletins (TSBs), etc., except where a specific date or version is otherwise indicated, or where otherwise mandated by a Governing Authority.
- E. In the event of conflict between the Governing Requirements and/or conflict between the Governing Requirements and the Construction Documents:
1. With regards to the preparation of proposals and/or bids, the Contractor shall assume the more stringent (costly) condition shall prevail. The Contractor shall notify the Engineer of such discrepancy a minimum ten (10) working days prior to the bid date.
 2. With regards to actual construction, the Contractor shall notify the Engineer and await the Engineer's instruction prior to proceeding with procurement and/or installation.
- F. In the event of conflict between a code and a non-code Governing Requirement, or between a code and the Construction Documents, the code shall govern. However,

compliance with code requirements shall not be construed as relieving the Contractor from complying with any requirements of the non-code Governing Requirement or Construction Documents which may be in excess of code requirements and not contrary to same.

- G. If the requirements of this section or the Project Drawings exceed those of the governing codes and regulations, then the requirements of this section and the Drawings shall govern. However, nothing in this section or the Drawings shall be construed to permit work not conforming to all governing codes and regulations.
- H. Errors or omissions in the Construction Documents do not relieve the Contractor from executing the work in accordance with the Governing Requirements.
- I. The Governing Requirements are incorporated by reference into these Specifications.

1.13 QUALITY ASSURANCE

- A. All equipment shall equal or exceed the minimum requirements of NEMA, ASME, ANSI, and Underwriters Laboratories.
- B. All material and equipment furnished shall be new, unused, and free from defects. Equipment shall be clean and free of damage and corrosion, and shall be of the best quality obtainable for the purpose intended.
- C. Where more than one of any specified item of equipment or material is required, such items shall be the product of one manufacturer throughout the facility.
- D. All materials used shall bear labels attesting to Underwriters Laboratory approval, provided a standard is established for the material in question.
- E. All materials shall conform strictly to the standards and specifications set forth in this document. Unless otherwise specified, all products furnished shall be designed, built, and installed in accordance with the latest and best practice of the electrical and telecommunications industry, and shall conform to the standards of the NEMA, ANSI, TIA/EIA, ICEA, IEEE, NEC, and this Specification wherever they apply.

1.14 CONTRACTOR QUALIFICATIONS

- A. The Cable Contractor shall have a full working knowledge of low voltage applications such as, but not limited to data, voice, wireless, video surveillance, access control and audio/visual systems. The contractor shall have the following qualifications:
- B. Possess those licenses/permits required to perform telecommunications and other low voltage installations in the specified jurisdiction.
- C. Have personnel trained and certified in the design and installation of the manufacturer's structured cabling system and equipment.

- D. The Cable Contractor shall provide proof of current certification in the design and installation of the manufacturer's structured cabling system and equipment.
- E. The Cable Contractor shall provide the resume of the project manager assigned to oversee the installation.
- F. The Cable Contractor shall have a minimum of five (5) years of experience and five (5) years in business in this specialized field and shall have completed a minimum of three (3) projects similar in scope and size to this project.
- G. Have personnel knowledgeable in local, state and national codes and the latest BICSI and Telecommunications Standards.
- H. Provide proof of insurance for liability and workmen's compensation for all personnel on the jobsite.
- I. Contractor personnel will be required to provide and use the proper tools in the performance of each activity. The tools must be in good working order. The Owner reserves the right to review the tool lists and tool maintenance procedures of the Contractor.
- J. Other contractor qualifications as described in Division 27 & 28.

1.15 SITE SAFETY AND ACCESS

- A. Determine from General Contractor all job site requirements such as site access, parking, and material storage areas.
- B. The Contractor working on the job site must follow all safety rules set by the General Contractor. All technicians must furnish their own safety equipment including but not limited to hard hats, safety glasses, proper footwear (confirm if steel toed boots/shoes are required), fall arrest equipment, gloves, and safety vests. All safety equipment must be in good working order.
- C. If required by General Contractor, attend all safety orientations and meetings.
- D. Provide to General Contractor an up to date MSDS binder listing materials planned for use on the job site that require MSDS information. Provide the number of copies requested.

1.16 PERMITS AND FEES

- A. The Contractor shall obtain and pay for all licenses, permits and inspections required by the laws, ordinances and rules governing work specified herein. Such fees shall be included in the bid amount.
- B. The Contractor shall schedule and coordinate all inspections of the work as required, and shall provide all assistance as required by the inspector(s) during their inspection(s).

1.17 SUBSTITUTIONS AND DEVIATIONS

- A. Substitutions and deviations shall be in accordance with the applicable portions of Division 1. The requirements below expand upon and/or supplement the requirements in Division 1. In the event of discrepancies between these requirements and those defined in Division 1, the requirements of Division 01 shall take precedence.
- B. Prior to award of contract:
 - 1. Bids shall be based on products and methods of construction as specified.
 - a. Substitution of product and deviations from the methods of constructions specified which are used in the Contractor's bid shall be at the sole risk of the Contractor, and as such are subject to rejection without consideration during submittal review, should the Contractor be awarded the contract.
- C. After award of contract:
 - 1. Proposed substitution and deviation requests shall be reviewed during the time of Submittal review.
 - 2. Conditions for Consideration: Substitution and deviation requests will be received and considered only when one or more of following conditions are satisfied:
 - a. The specified product or method of construction cannot be provided within the contract period.
 - b. The specified product or method of construction cannot receive necessary approval by a Governing Authority, and the requested substitution can be approved.
 - c. The specified product or method of construction cannot be provided in a manner that is compatible with other materials.
 - d. A substantial advantage is offered to the Owner, in terms of cost, time, or other considerations of merit.
 - e. The product as specified includes the statement "Or Equal."
 - 3. Conditions for Rejection: Substitution and deviation requests will be rejected for the following reasons, among others:
 - a. The conditions for consideration (see above) have not been met.
 - b. Extensive revisions to the Construction Documents are required to support the proposed changes.
 - c. The proposed changes do not comply with the general intent of the Construction Documents.
 - d. The substitution request is for product which does not include the statement, "Or Equal," or is specified as "no substitute," "substitutions are not acceptable," "provide as specified" or similar.
 - e. The proposed change is solely for the convenience or economic gain of the Contractor.
- D. Approval of substitution and deviation requests:
 - 1. The Contractor shall not proceed with a substitution or deviation without written approval.

- a. The Contractor shall be responsible for fees incurred by the Engineer for any redesign resulting from the proposed changes, and for the updating of the Construction Documents to reflect such changes.

1.18 SUBMITTALS

- A. Submittals shall be in accordance with the applicable portions of Division 01 and 27. The requirements below expand upon and/or supplement the requirements in Division 01. In the event of discrepancies between these requirements and those defined in Division 01, the requirements of Division 01 shall take precedence.
- B. Submittals shall include product data literature and adequate descriptive literature, catalog cut sheets, and other data necessary for the Technology Designer and Architect/Engineer to ascertain that the proposed equipment and materials comply with the specification requirements.
- C. The Cable Contractor shall not purchase any materials or equipment for incorporation into the project prior to receipt of reviewed Submittals from the Technology Designer and/or Architect/Engineer.
- D. Review of product data shall not relieve the Cable Contractor from responsibility for deviations from the drawings or specifications, unless the Contractor has, in writing, called attentions to such deviations at the time of submission and secured written approval.
- E. General:
 - 1. Submittal review is a courtesy extended to the Contractor for the limited purpose of checking for general conformance with the design concept and the information shown in the Construction Documents.
 - 2. The Contractor shall provide submittal information as soon as practicable after the date of Notice to Proceed, but no later than 60 days after contract award and prior to the purchase, delivery, fabrication, and installation of product.
 - 3. In the event of discrepancies or conflict between Submittals and the Construction Documents, either prior to or after review, the requirements of the Construction Documents shall prevail.
 - 4. Submission of material for review, regardless of the outcome of the review, does not alter the Contractor's obligation to follow the intent of the Construction Documents, nor the Contractor's responsibility to comply with the Construction Documents.
 - 5. Submittals will not be reviewed and will be returned to the Contractor without review for the following reasons:
 - a. Submittal package does not conform to the requirements listed herein.
 - b. Submittal is for a product or method of construction not required by the Construction Documents.
 - c. Submittal is partial or incomplete.
 - d. Submittal contains information concerning the proposed implementation of means, methods, procedures, sequences or techniques, temporary aspects of the

construction process, or other items, which are the sole responsibility of the Contractor.

- e. Submittal was not carefully reviewed by the Contractor prior to submission, as evidenced by poor organization, obvious or numerous errors, lack of correlation or cross-referencing, lack of clarity in presentation, or containing Shop Drawings which do not meet the standard of the Construction Drawings.
 - f. Submittal was submitted directly from the Contractor's subcontractor(s) or vendor(s).
 - g. Subcontractor and/or vendor submittal information was not carefully reviewed and/or approved by the Contractor.
 - h. Submittal does not bear the Contractor's approval stamp, and/or contains subcontractor and/or vendor submittal information which does not bear the Contractor's approval stamp.
- F. Submittal contains substitution and/or deviation requests, which are not clearly identified as substitution or deviation requests in a separate "Substitution and Deviation Requests" section of the Submittal.
- 1. Submittals shall be submitted as a single package and shall include subcontractor and vendor submittal information.
 - 2. Each submittal (or re-submittal) set shall bear a unique Contractor's submittal sequence number.
 - 3. Requests for substitution shall only be included under the "Substitution and Deviation Requests" section of the submittal (see below) and shall comply with the requirements of "Part 1 – General, 1.10 Substitutions and Deviations" herein. Submission of substitution requests in any other portion of the Submittal does not constitute an acceptable or valid request for substitution, nor will review of such information constitute approval in any manner.
 - 4. Submittals and shop drawings are required per the submittals schedule at the end of this Section.
- G. Submittal Format:
- 1. Submittals shall be in a letter-sized (8-1/2 x 11 inch) 3-ring binder with hardboard covers and under separate cover from submittals furnished under other Divisions.
 - 2. Front cover of Submittal shall indicate the name of the project, the project number, the name of the Owner, year of completion, the title "Telecommunications Submittals," and the names of the Engineer and Contractor, as well as the General Contractor.
 - 3. Submittals shall include a table of contents identifying sections, specification sections, and page numbers.
 - 4. Information provided in the submittal shall follow the same general order of the Specifications.
 - 5. Submittals shall be sectionalized and indexed with titled tab dividers (by section name – not numbered and not handwritten).
 - 6. Sections shall be (see Submittal Sections below for more detail regarding each section):

- a. Product Data
 - b. Shop Drawings
 - c. Technical Drawings (if applicable)
 - d. Samples (if applicable)
 - e. Substitution and Deviation Requests (if applicable)
 - f. Other Information (if applicable)
- 7. Within each section, information shall be organized by Specification Section and/or Drawing to which the information applies.
- H. Pages shall be numbered.
- I. Drawings (except for full and half-size Shop Drawings or Technical Drawings), if not in 8-1/2 x 11-inch size, shall be bound and accordion folded to 8-1/2 x 11-inch size.
- J. Quantity: Submit copies in quantities per the requirements of Division 01.
- K. Submittal Sections: Submittals shall be sectionalized and shall include sections for Product Data, Shop Drawings, Technical Drawings, Samples, Substitution and Deviation Requests, and Other Information (see Submittal Format herein).
 - 1. Product Data: Submit Product Data information as called for in the individual Specification Sections. Product Data shall include:
 - a. For product which is being provided as specified, do not provide product data. Instead, provide a list of all products to be provided as specified and state in writing that each product in the list is being provided as specified.
 - b. For all other product other than that specified, provide the following product information (as applicable):
 - 1) Specification Section to which the product applies.
 - 2) Catalog cut sheets, manufacturer data sheets, and/or specification sheets detailing the product, item, assembly, and installation.
 - 3) Manufacturer's printed recommendations (if not included in the above).
 - 4) Written description.
 - 5) Notation of dimensions verified by field measurement.
 - 6) Notation of coordination requirements.
 - 7) Compliance with recognized trade association and testing agency standards.
 - 8) Highlighted details within the product data that identifies compliance with the Construction Documents or the intent of the Construction Documents.
 - 9) Highlighted details within the product data that identifies deviations from the Construction Documents or the intent of the Construction Documents.
 - c. For products for which the Contractor is proposing a substitution, include the product as specified in the submittal per the above requirements and list the reference to the proposed substitution in the "Substitution and Deviation Requests" section of the submittal (see below).
 - d. Do not provide product quantities – quantities are the sole responsibility of the Contractor and will not be reviewed.

2. Shop Drawings: Submit Shop Drawings as called for in the individual Specification Sections. Shop Drawings shall include:
 - a. Shop drawings shall contain design details, fabrication installation drawings, detailed drawings, schedules, diagrams, templates, and other drawings that show adaptation or installation of products. Shop Drawings shall include the following information:
 - 1) Specification Section(s) to which the Show Drawing applies.
 - 2) Dimensions.
 - 3) Identification of products and materials included.
 - 4) Compliance with specified standards.
 - 5) Notation of coordination requirements.
 - 6) Notation of dimensions established by field measurement.
 - 7) Notation of details that identify compliance with the Construction Documents or the intent of the Construction Documents.
 - 8) Notation of deviations from the Construction Documents or the intent of the Construction Documents.
 - 9) Indication of sectionalized manufacturing of equipment (i.e. for oversized equipment that cannot be installed as a single component).
 - 10) Shop drawings shall be provided in form, format, and size identical to that of the Construction Drawings (the Construction Drawings set the standard). Shop Drawings that do not meet this standard shall be rejected without review.
 - 11) Title Block: May be the Contractor's Title Block, but shall indicate Project name, manufacturer's name and logo, date of submittal, content of sheet, and sheet number.
 - 12) Floor Plans: Plan titles, scales, north arrows, column lines, line types, fonts, and room names and numbers shall match that of the Construction Drawings.
 - 13) For methods of construction for which the Contractor is proposing a deviation, include the method of construction as specified per the above requirements and list the reference to the proposed deviation in the "Substitution and Deviation Requests" section of the submittal (see below).
3. Technical Drawings: Submit Technical Drawings as called for in the individual Specification Sections.
4. Samples: Submit Samples as called for in the individual Specification Sections.
 - a. Samples shall be indexed in this section and provided as an attachment to the Submittal.
5. Substitution and Deviation Requests: For each substitution and/or deviation request, include the following:
 - a. Whether the request is for substitution of product or deviation from a construction method.
 - 1) The Specification Section(s) or Drawing to which the request applies.
 - 2) Reason for the request (Note: the reason must conform to the requirements of "Part 1 – General, Substitutions and Deviations" herein)
 - b. If a substitution, provide:

- 1) Specified product to which the proposed substitution applies.
- 2) Product data for the substituted product.
- 3) Notation of differences between the proposed substitution and the specified item.
- c. If a deviation, provide:
 - 1) Specified method of construction to which the proposed deviation applies.
 - 2) Shop Drawing data for the deviation.
 - 3) Notation of differences between the proposed deviation and the specified construction method.
- d. Written statement signed by the Contractor stating that the proposed substitution or deviation is equivalent or superior in function, appearance, and quality to the specified product or construction method and that the proposed substitution or deviation will be at no additional cost to the Owner.
6. Other Information:
 - a. Contractor Statement of Qualifications.
 - b. Submit Other Information as called for in the individual Specification Sections.
- L. Submittal review:
 1. The submittal review will not include review of the accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes, construction means or methods, coordination of work with other trades, or construction safety precautions, all of which are the sole responsibility of the Contractor.
 2. Corrections or comments made on the Submittal by the reviewer during the submittal review do not relieve the Contractor from compliance with the requirements of the Construction Documents.
 3. Review of a specific item shall not indicate that the reviewer has reviewed the entire assembly of which the item is a component.
 4. Review does not relieve the Contractor from responsibility for errors, which may exist in the submitted data.
 5. Review of substitutions and deviations:
 - a. The reviewer shall not be responsible for review of substitutions and/or deviations that were not brought to the attention of the reviewer by specific inclusion of the substitution and/or deviation in the Substitution and Deviation Requests section of the Submittal.
 - b. Where a substitution and/or deviation is not included in the Substitution and Deviation Requests section of the Submittal, the procurement and installation of the substitution and/or deviation is at the sole risk of the Contractor.
 - c. If the Reviewer does not specifically note substitutions and/or deviations, it remains the Contractor's responsibility to comply with the Construction Documents.
- M. After review, submittals shall be returned together with review comments and specific actions (if required) to be taken by the Contractor. Typical comments and actions will be:

1. No Exceptions Taken
 2. Revise and Resubmit - Re-Submittal Required
 3. Make Corrections Noted - Re-submittal not Required
 4. Submit Specified Items
 5. Rejected
 6. Submittal Not Required & Not Reviewed
- N. The Contractor shall perform no portion of the Work requiring a submittal until the respective submittal has been approved by the Architect/Engineer/General Contractor. Such Work shall be in accordance with the approved submittal.
- O. Re-submission of submittals:
1. Submittals shall continue to be re-submitted and reviewed until all submitted items are marked by the Engineer as "No Exceptions Taken" or "Make Corrections Noted (Re-submittal Not Required)."
 2. Re-submittals shall be clearly identified as a re-submittal and shall identify changes on a separate Revisions page inserted after the Table of Contents page(s).
 3. The Contractor shall be responsible for fees incurred by the Engineer resulting from subsequent review of re-submittals that fail to meet the requirements herein. Such fees will be incurred after the Engineer has reviewed the original submission and one re-submission.

1.19 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store and handle products in full compliance with the manufacturer's recommendations and/or instructions, using means and methods that will prevent damage, deterioration, and loss (including theft).
- B. The Contractor shall protect product until final acceptance.
- C. Protection of product is the sole responsibility of the Contractor. The Contractor shall be responsible for replacing damaged, deteriorated, or lost product at no additional cost to the Owner.
- D. Products subject to damage by the elements shall be stored above ground, under cover, in a weather tight enclosure, with ventilation adequate to prevent condensation. Temperature and humidity shall be maintained within the manufacturer's recommendations.
- E. The Contractor shall make provisions for receiving and storing product, including Owner furnished product to be installed by the Contractor as part of the work.
- F. Product shall be carefully inspected for damage upon delivery. Defective or damaged product shall be marked "Rejected," removed from the site, and shall not be installed.

- G. The Contractor shall arrange product deliveries in accordance with the construction schedule. Deliveries shall be scheduled to maintain the progress of work, to avoid conflict with the work of other Trades, and to accommodate site conditions.
- H. Product shall be delivered to the site in the manufacturer's original containers, complete with labels and instructions for the proper handling, storage, unpacking, protection and installation.
- I. The Contractor shall ensure that product to be installed is not temporarily used as steps, ladders, platforms, scaffolds, or for storage by the Contractor or by other Trades during the construction process. Equipment found used in such a manner will be considered "damaged," shall not be installed, and shall be replaced at no additional cost to the Owner.

1.20 COORDINATION

- A. The Contractor shall contact the Exante360 project manager once project is awarded and prior to construction to discuss project approach, schedule, and coordination.
- B. The Contractor shall thoroughly examine the Construction Documents, including Drawings and specification Sections of other Divisions, for construction details and methods that are dependent upon or will affect the work of other trades. The Contractor is responsible for identifying coordination issues and dependencies, and for preparing Shop Drawings, work plans and schedules to accommodate and/or mitigate coordination issues and dependencies before they arise.
 - 1. Changes necessitated by the failure of the Contractor to coordinate with the work of other trades shall be at no additional cost to the Owner or project.
- C. The Contractor shall confer and cooperate with the other trades, throughout the entire construction process, in order to coordinate the work in the proper sequence. Typical coordination issues include but are not limited to:
 - 1. Electrical work, including electrical receptacles, power panels, transformers, telecommunications grounding system, and the installation of raceway, device boxes, conduits, and sleeves for the Communications Cabling System.
 - 2. Location of cabinets, counters, and doors so that communications outlets, other system outlets and equipment are clear from and in proper relation to these items.
 - 3. Mechanical work, including HVAC systems and ductwork, piping, and mechanical chases.
 - 4. Ceiling cavity spaces.
 - 5. Installation of acoustical ceiling tiles and similar finishes that may conceal the work.
 - 6. Build-in of oversized equipment during structure construction.
 - 7. Required separation distances.
 - 8. Access routes for equipment through the construction
 - 9. Cutting/coring of floor, ceiling, or wall structures.

- D. Digital format copies of bid drawings will be furnished to the successful bidder. Augment bid documents with additional information to ensure coordination between trades. Provide digital format communications systems drawings showing all ceiling devices, raceways and cable tray locations and routing to mechanical contractor to be used for coordination drawings provided by mechanical contractor. Include dimensions and elevations of devices, raceway, and cable tray.
- E. The Contractor shall coordinate communications service installations with the Owner, Owner Vendors and with the Service Provider(s) as required.
- F. Existing communications service outages shall be coordinated and scheduled in advance with the Owner at a time and duration acceptable to the Owner. Outages scheduled at times other than the normal working hours shall not entitle the Contractor to additional compensation beyond the original amount bid. Outages without advance notice and prior approval by the Owner are not acceptable.
- G. The Contractor shall review the Drawings and Specifications of other Divisions for locations of devices and equipment requiring communications connectivity not specified in this Division or shown on the Communications Drawings. The Contractor shall coordinate the locations of these items with the other trades, and shall verify locations with the Engineer and Owner prior to rough-in.
- H. Verify that the physical dimensions of each item of equipment fit the available space, promptly notify the Engineer of any potential conflicts, and await the Engineer's direction prior to purchase and rough-in of the equipment.
- I. Coordinate locations of devices, outlets, etc. with field conditions, unless such locations are specifically dimensioned or otherwise noted in the Construction Documents. If so noted, verify location with other affected trades and against existing field conditions, promptly notify the Engineer of any potential conflicts, and await the Engineer's direction prior to purchase and rough-in of the equipment.
- J. Consult the architectural drawings for the exact height and location of all communications and nurse call equipment not specified herein or shown on the drawings. Make any minor changes (less than 6" horizontal) in the location of the raceways, outlets, boxes, devices, cabling, etc., from those shown on the drawings without extra charge, where coordination requires or if so directed by the Architect before rough-in.
- K. Coordinate locations for chases, slots, sleeves, and openings in the building structure. For new concrete coordinate, locate and provide chases, slots, sleeves, and openings prior to the pouring of the concrete.

1.21 RECORD DOCUMENTS

- A. The Contractor shall maintain a set of Record Documents showing all additions, changes, and deletions that have been made to the original Drawings and Specifications throughout the course of construction, as well as reviewed Submittal data.

1. Items to be noted shall include but shall not be limited to:
 - a. Routing of concealed raceways/pathways;
 - b. Raceways/pathways located more than 2 feet from where shown on the original Contract Documents;
 - c. Raceways and main pathways (pathways with more than 30 cables) not shown on the Contract Documents;
 - d. Concealed equipment;
 - e. Stub-outs; actual equipment locations, sizes and dimensions;
 - f. Building outline changes;
 - g. Addenda, accepted Alternates, Change Orders, other document revisions which occurred after the award of the Contract and/or the start of construction activities;
 - h. System component labels and identifiers for all major components.
 - i. Telecom Room detail sheets
2. Notations shall be handwritten in a neat and legible manner and shall be noted as follows:
 - a. Red – for additions and changes
 - b. Green – for deletions
 - c. Blue – for notes

B. Record Documents shall:

1. Be kept current (i.e. no more than one week behind actual construction) throughout the course of construction.
2. Be retained at the job site until Final Acceptance.
3. Be made readily available at all times to the Owner's representative.
4. Not be the Contractor's working documents.
5. Be protected from deterioration and loss in a secure, fire-resistive location.
6. Be made readily available to the Engineer for review of completeness and accuracy throughout the course of construction.
7. At project closeout, be updated with the items on the Known Exceptions/Deviations List per the requirements of subsection "3.10 Project Close-Out" herein. Include only those items marked "Approved" by the Engineer.

C. Submission: The Record Drawings shall be submitted to the Engineer as part of the Operating and Maintenance Manual (see subsection "1.014 Operating and Maintenance Manual" herein).

1. Handwritten notations on the Record Drawings shall be REVIT drafted by the Contractor onto a final, fresh set of Construction Drawings prior to submission. Record Drawings shall be provided in form, format, size, and REVIT version identical to that of the Construction Drawings (the Construction Drawings set the standard). Record Drawings that do not meet this standard shall be rejected without review.
2. The Record Drawings shall be reviewed by the Contractor for accuracy and completeness prior to submission.

1.22 OPERATING AND MAINTENANCE (O&M) MANUALS

A. General:

1. O&M Manuals shall be submitted in accordance with the applicable portions of Division 1.
2. O&M Manuals shall be submitted as a single package and shall include subcontractor and vendor O&M information.
3. Catalog pages and data included in O&M Manuals shall be originals. Where not possible to obtain original copies in sufficient quantity, catalog pages and data shall be neat, clean copies of the originals.
4. O&M Manual Requirements: O&M Manuals shall include Product Data, Service, Spare Parts, Tests/Measurements/Calibration Settings, Record Drawings, Warranty information, and Other Information as required.
5. Product Data: Include the product data provided in the Submittal reflecting product as supplied and installed, as well as additional information such as installation, operation, and routine maintenance information.
6. Service: Assemble service information (cleaning, adjustments, frequency, etc.) for each device requiring service. For devices requiring qualified service, compile an index of qualified service providers (and their contact information) able to service these devices.
7. Tests: Assemble all test documentation made for each system and/or device requiring testing.
8. Record Drawings: Provide Record Drawings per the requirements of – subsection “V” herein.
9. Warranty: Provide warranty documentation per the requirements of the individual Specification Sections.
10. O&M Manual contents shall also be submitted in soft/electronic copy on compact disc.

B. O&M Manual format:

1. O&M Manuals shall be bound in one letter-sized (8-1/2 x 11 inch) hard cover (hard back or loose leaf) binder.
2. Front cover of the O&M Manual shall indicate the name of the project, the project number, the name of the Owner, year of completion, the title “Communications O&M Manual,” and the names of the Engineer and Contractor, as well as the General Contractor.
3. Side cover of the O&M Manual shall indicate the name of the project, the project number, the name of the Owner, and the title “Telecommunications O&M Manual.”
4. O&M Manual shall include the following sections, indexed (with tab dividers) accordingly.
 - a. Product Data
 - b. Service
 - c. Spare Parts
 - d. Tests

- e. Calibration/Configuration Settings
 - f. Record Drawings
 - g. Final Punch list
 - h. Certificates of Inspection
 - i. Warranty
- C. Contractor's Warranty Certificate
 - 1. Manufacturer's Warranty Certificate (as applicable)
- D. Other Information (as applicable)
 - 1. O&M Manuals shall include tab dividers, titled (not numbered) for each section. Tab dividers shall not be handwritten.
 - 2. O&M Manuals shall include a table of contents identifying sections and page numbers.
 - 3. Pages within each section shall be numbered.
 - 4. Drawings (excluding full size Record Drawings) shall be bound and accordion folded to 8-1/2 x 11-inch size.
- E. O&M Manual submission:
 - 1. The Contractor shall submit one draft copy of the O&M Manual for review and approval by the Engineer.
 - a. The submission will be reviewed for accuracy, completeness, and compliance to the requirements herein. A submission which fails to meet these requirements will be rejected and returned to the Contractor together with review comments and specific actions to be taken by the Contractor. The Contractor shall revise the O&M Manual and re-submit for review and approval.
 - b. The O&M Manual shall continue to be re-submitted and reviewed until such time as the O&M Manual is approved by the Engineer.
 - c. The Contractor shall be responsible for fees incurred by the Engineer resulting from subsequent review of O&M Manuals that fail to meet the requirements herein. Such fees will be incurred after the Engineer has reviewed the original submission and one re-submission.
- F. Upon approval of the draft copy, the Contractor shall submit final copies in quantities per the requirements of Division 01.

Final payment to the Contractor will not be authorized until the final copies of the O&M Manuals (including Record Documents) have been received and approved by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide materials that meet the following minimum requirements:

Common Work Results
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1. Cabling and components shall be by the manufacturer specified or an approved equal unless no substitutions are allowed. Where no manufacturer is specified, components shall meet or exceed the performance specifications given.
 2. Electrical equipment and systems shall meet UL standards and requirements of the NEC. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with these requirements.
 3. Equipment shall meet all applicable FCC regulations.
 4. All materials, unless otherwise specified, shall be new, unused and the standard products of the manufacturer. Used equipment or damaged material will be rejected.
 5. The listing of a manufacturer as "acceptable" does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems must conform to the Specifications and meet the quality of the design make.
 6. Where applicable, all materials and equipment shall bear the label and listing of Underwriters Laboratory. Application and installation of all equipment and materials shall be in accordance with such labeling and listing
 7. The Contractor is responsible for providing all incidental and/or miscellaneous tools, scaffolding, consumable items, testing equipment appliances, and other hardware not explicitly specified or shown on the Drawings required for the installation of a complete and operable telecommunications infrastructure system ready for the Owner's use.
- B. Products shall be:
1. New (except as otherwise indicated) and free from defects.
 2. Standard products of manufacturers regularly engaged in the production of such products.
 3. Of the manufacturer's latest standard design.
 4. Designed to ensure satisfactory operation and life in the environmental conditions that prevail in their installation location.
- C. Where systems are indicated, provide component products manufactured by a single system manufacturer.
- D. Prior to ordering and delivery of equipment, the Contractor shall:
1. Verify that the equipment shall adequately pass through building openings and passageways with unobstructed access to the final equipment location. When building openings and passageways will not permit the equipment to pass through unobstructed, equipment shall be manufactured and shipped in sections for final assembly at the equipment location. Submittals shall indicate sectionalized manufacturing of equipment.
 2. Verify that the equipment shall properly fit the space allocated, that required clearances could be maintained, and that the equipment can be located without interference from other systems, structural elements, or the work of other trades.

2.2 WORKMANSHIP, SUBSTITUTIONS, AND WARRANTY

- A. Materials and workmanship shall meet or exceed industry standards and be fully eligible for the maximum guarantee offered by the manufacturer. All components, material, and workmanship not covered by the manufacturer's system warranty shall be guaranteed for two years after the date of final acceptance. Cable integrity and associated terminations shall be thoroughly inspected, fully tested, and guaranteed as free from defects, transpositions, opens, shorts, kinks, damaged jacket insulation, or similar conditions that may compromise system performance.
- B. All labor must be thoroughly competent and skilled, and all work shall be executed in strict accordance with the best practice of the trades.
- C. Cable Contractor shall be responsible for and make good, without expense to the Owner, any and all defects arising during this warranty period that are due to imperfect materials, appliances, improper installation, or poor workmanship.
- D. Approval of alternate or substitute equipment or material in no way voids Contract document requirements.
- E. Under no circumstances shall the Owner be required to prove that an item proposed for substitution is not equal to the specified item. It shall be mandatory that the Cable Contractor submit to the Owner all evidence to support his contention that the item proposed for substitution is equal to the contract specified item. The Owner's decision as to the equality of substitution shall be final and without further recourse.
- F. The Contractor is to be certified by the manufacturer to install the cabling system and to furnish to the Owner a system warranty that has a minimum period of 25 years. Such warranty will cover all cable and components installed as part of the manufacturer's cabling system and shall include a performance warranty that guarantees the horizontal and backbone cabling system will support the performance specifications as stated in ANSI/TIA/EIA 568-B. Copper links shall be warranted to the link performance minimum expected results defined in ANSI/TIA/EIA-568-B.2-1. Fiber-optic links shall be warranted to the link and segment performance minimum expected results defined in ANSI/TIA/EIA-568-B.1.
- G. The Contractor at the time of Bid is not required to be certified.
- H. The Cable Contractor shall provide a certified warranty for both parts and labor for a minimum period of 25 years upon final acceptance of the system by Owner. The Contractor shall provide a copy of the warranty certificate to the Architect/Engineer and Owner for review.

PART 3 - EXECUTION

3.1 STRUCTURED CABLING

- A. All material and equipment shall be installed in a neat and workmanlike manner.

- B. All material and equipment shall be installed per manufacturer's specifications, using methods and tools approved by the manufacturer.
- C. All material and equipment shall be installed per the drawings.
- D. The installation shall be in compliance with the requirements of the NEC, OSHA and the rules, regulations, and requirements of the FCC.
- E. The installation shall be in compliance with federal, state, county and city laws, regulations, ordinances, and codes applicable to the installation.
- F. The locations of floor boxes, stub-ups, outlets, panels, equipment racks and other related equipment as indicated on the drawings are approximate and are understood to be subject to such revision as may be found necessary at the time of installation. The Contractor should have exact and definite locations accepted by the Owner before proceeding with the installation.
- G. For telecommunications outlets in wall mounted applications, the Electrical Contractor shall furnish and install electrical backboxes with a single-gang mud ring reducer for flush mounting single gang faceplates in the wall space along with conduit from the gang box to wire ways located in accessible spaces. See backbox and conduit schedule in Drawings for sizing requirements.
- H. For telecommunications outlets in floor mounted applications, the Electrical Contractor shall furnish and install floor boxes within the floors and any floor duct or conduits necessary to convey cable to wire ways in accessible spaces.
- I. The Contractor shall furnish and install wire pathways to fully support all installed cable. Pathways may consist of J-hooks rated for Category 6 cable, basket tray or ladder rack as called out in the drawings and/or specifications. The Contractor shall coordinate wire raceway installation with other trades so as not to impede their work.
- J. The Contractor shall furnish and install ladder rack and wire raceways within the TDR(s) and TEC. The ladder rack and wire raceways shall include all accessories for a complete routing system.
- K. The Contractor shall furnish and install equipment racks, frames or cabinets as called out in the drawings and/or specifications.
- L. Provide all cable hangers, horizontal and vertical wire managers, cross-connect managers, and other cable management hardware for a neat and orderly installation.
- M. Horizontal cabling shall not be spliced and must be continuous from the cross-connect to the workstation outlets.
- N. All copper backbone cabling shall not be spliced but must be continuous from termination point to termination point.

- O. All fiber optic backbone cables shall be plenum rated armored terminated with LC connectors unless otherwise specified.
- P. The proximity of horizontal and backbone cabling to electrical facilities that generate high levels of electromagnetic interference (EMI) shall be taken into account. These facilities include, but are not limited to copiers, motors, transformers, and fluorescent lighting. TIA/EIA 569-C standards shall provide separation requirements.
- Q. All horizontal cables shall be terminated according to the T568-B wiring scheme unless otherwise specified.

3.2 GROUNDING AND BONDING

- A. Grounding shall meet the requirements as noted in the Division 27 specifications and practices of applicable authorities and codes. In addition, telecommunications grounding and bonding shall conform to ANSI/TIA Standard 607-B.
- B. A telecommunications grounding bus bar (TGB) shall be installed by the electrical contractor in each telecommunications data/equipment room. The TGB shall be connected to the main building ground system.
- C. The Contractor shall ground all equipment racks, frames, cabinets, ladder rack and basket tray to room TGB using minimum #6 AWG wire with green sheath. Use bonding jumpers between each section of ladder rack or basket tray and between ladder racks or basket trays and equipment racks, frames, and cabinets.

3.3 FIRESTOP

- A. All telecommunication pathways that penetrate fire-rated walls, floors or ceilings shall be properly fire stopped, per the applicable codes, Division 27 specifications and Drawing and be the responsibility of the Contractor.
- B. Provide fire-resistant UL approved fire stopping systems to restore fire ratings to all wall, floor, or ceiling penetrations. Fire stopping systems must be UL classified and meet NEC and local codes.
- C. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, fire, toxic gas, or water through the penetration, before, during, or after a fire. The fire rating of the penetration seal shall be at least that of the floor or wall into which it is installed, so the original fire rating of the floor or wall is maintained as required by Article 300-21 of the NEC.
- D. No flammable material may be used to line the chase or hole in which the firestop material is to be installed.
- E. All fire stopping materials shall be installed in accordance with the manufacturer's directions and recommendations.

- F. The sealant shall remain resilient and pliable to allow for the removal and/or addition of cable without the necessity of drilling holes. It shall adhere to itself in order to allow any and all repairs to be made with the same material. It shall allow for vibration, expansion and/or contraction without affecting the seal, cracking, crumbling and spilling.
- G. The firestop sealant shall comply with the fire-exposure and hose-stream endurance requirements of ASTM E-119.

3.4 LABELING

- A. Cable labels shall provide a unique identification scheme that shall ease cable tracing. The Contractor shall coordinate with Owner to determine any Owner required labeling schemes prior to administering cable management techniques. If Owner does not furnish a cabling administration scheme, the Contractor shall submit intended labeling scheme to the Technology Designer, Architect/Engineer and Owner for approval.
- B. Labels shall be permanent, waterproof, and readable from one foot with permanent lettering and shall not be removable by normal cable handling or normal operations. As part of the final installation, no hand-written labels will be allowed. All labels shall be typed or computer generated.
- C. Verify labeling for all cables, termination blocks, patch panels, and racks with Owner prior to installation.
- D. All cables shall be computer generated labeled at each end, for proper administration, additional cable labeling may be required on the cable at intermediate locations such as conduit ends and along cable tray and cable support runs.

3.5 TESTING

- A. The Contractor shall test 100% of all cables installed. Telecommunications cables shall meet or exceed the ANSI/TIA-568-C specifications for the category of cable installed. All test reports shall be printed and included in the final record documentation package.

3.6 UTP COPPER CABLING

- A. The Cable Contractor shall be responsible for recording all test data and per the specifications.
- B. Copies of all test results are to be submitted to the Owner or authorized representative for review as part of the final record documentation package and remain with the Owner for their records.
- C. Category 6 cabling systems shall be performance verified using an automated test set. Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria, and the result shown as pass/fail. Test results shall be printed directly from the test unit or from a download file using an application from the test equipment

manufacturer. The printed test results shall include all tests performed, the expected test result and the actual test result achieved. The test shall be a permanent link test and test for the following performance parameters:

1. Wire Map
2. Length
3. Insertion Loss
4. Pair-to-Pair Near End Crosstalk (NEXT)
5. Power Sum Near End Crosstalk (PSNEXT)
6. Equal Level Far End Crosstalk (ELFEXT)
7. Power Sum Equal Level Far End Crosstalk (PSEFFEXT)
8. Return Loss (RL)
9. Propagation Delay
10. Delay Skew

3.7 FIBER OPTIC BACKBONE CABLING

- A. Follow procedures described in TIA/EIA TSB-140 for Tier 1 tests when testing intra-building fiber optic backbone cables. Multimode links are to be tested at 850 nm and 1300 nm in accordance with ANSI/TIA/EIA-526-14-A, Method B, One Reference Jumper. Single-mode links are to be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper. Test fibers in one direction unless otherwise directed.
- B. Test for system attenuation using a power meter and light source set to the same wavelength. Power meter must be calibrated and traceable to the National Institute for Standards and Technologies (NIST).
- C. Test jumpers must be of the same optical fiber core size as the cabling system (e.g. test 50/125µm systems using 50/125 µm jumpers).
- D. Test 100% of installed fiber. Provide printed test reports for inclusion in final record documentation package. Test reports will show measured loss for each fiber in dB and length of each fiber in feet.
- E. End to end testing is considered to be from the equipment end through the cross-connect to the terminal end.
- F. TSB 140 Tier 2 to include OTDR testing.

3.8 OTHER CABLES

- A. Other cables include:
 1. Security and Access control cables.
 2. Video surveillance UTP cables.
 3. Camera power and control cables other than UTP.

4. Intercom and paging cables.
5. Coaxial cables.
6. Audio and Visual cables.
7. Elapsed Timer cables.
8. Other systems defined on drawing and specs.
9. Test all cables for continuity.
10. Test cables per manufacture specifications.
11. Test cables per Division 27 specifications

3.9 IDENTIFICATION

- A. All contractor personnel shall be clearly identified by uniform and/or company badge with photo ID, employee's name, and company name. Contractor vehicles shall be equipped with signs on both sides of vehicle identifying the Contractor's company name.
- B. All Owner provided Contractor IDs shall be returned at or before project closeout.
- C. Completed work shall present a neat and professionally installed appearance. The appearance of the work shall be of equal importance to its operation. Failure to present a neat and professionally installed appearance shall be considered sufficient reason for rejection of the system in part or in whole.
- D. Completed work shall demonstrate quality workmanship. Quality workmanship shall be of equal importance to its operation. Failure to demonstrate quality workmanship shall be considered sufficient reason for rejection of the system in part or in whole.

3.10 PERMITS AND FEES

- A. The Contractor shall make arrangements to obtain and pay for necessary permits, licenses, and inspections.
- B. No work shall be started prior to obtaining necessary permits and payment of required fees. Work installed prior to obtaining proper permits shall, if required by the Governing Authority (AHJ), be redone in compliance with requirements at no additional cost to the Owner.

3.11 ACCESS

- A. Install equipment such that it is readily accessible for operation and maintenance.
- B. Access to equipment shall not be blocked or concealed by conduits, supporting devices, boxes, or other items.
- C. Do not install equipment such that it interferes with the normal operation or maintenance requirements of other equipment.

- D. Place equipment labels and/or other identification where the label and/or identification can be easily seen and read without difficulty.

3.12 BUILDING ATTACHMENTS

- A. Equipment shall be installed level, plumb, parallel, and perpendicular to building structures and to other building systems and components, except where otherwise indicated.
- B. Equipment shall be securely fastened. Select fasteners so that the load applied to any one fastener does not exceed 25 percent of the proof-test load.
- C. Attachment of hanger rods, support cables, diagonal wall bracing, and any other connections made to the building structure after the fireproofing contractor has completed his work, shall be made with minimal impact to the existing fireproofing. The Contractor making such connections is responsible for:
 - 1. Removal of fire stopping where attachment is required.
 - 2. Scorings and over-cut as required for connection only. Contractor shall be held responsible for costs associated with the patch back of excessively removed fire stopping material by the General Contractor.

3.13 SUPERVISION

- A. The Contractor shall appoint a Project Manager who will be the single point of contact for all work accomplished under this Project and will be vested by the Contractor with the authority to make decisions on behalf of the Contractor.
- B. The Project Manager will be responsible to represent the Contractor and coordinate all aspects of this Project, including but not limited to:
 - 1. Overall and specific project responsibility
 - 2. Thorough knowledge of Project Specifications and Drawings
 - 3. Creation and maintenance of a project schedule, including milestones, task definitions and resource allocations
 - 4. Attendance at all Project Management meetings
 - 5. Supervision and direction of all Contractor personnel
 - 6. Documentation, including submittals and change orders
 - 7. Quality assurance of Project
- C. The Project Manager initially assigned to the Project shall be assigned to the Project for the duration of the Project. Once assigned by the Contractor, the Project Manager shall not be changed by the Contractor without Engineer and Owner approval.
- D. The Contractor shall assign a qualified Foreman to the Project and shall keep the Foremen on site and in charge of the work at all times. The Foreman shall be equipped with a mobile phone during project working hours.

- E. The Foreman initially assigned to the Project shall be assigned to the Project for the duration of the Project. Once assigned by the Contractor, the Foreman shall not be changed by the Contractor without Engineer and Owner approval.

3.14 DRAWINGS

- A. Unless specifically dimensioned or detailed, Drawings indicate approximate locations, arrangement, and general character. To avoid interference with structural members and equipment of other trades, or for the convenience of the Owner, it may be necessary to adjust the locations shown on the Drawings prior to installation. Unless specifically dimensioned or detailed, and with the exception of locations of equipment and raceway in Telecommunications Data/Equipment Rooms, the Contractor may make minor location adjustments without obtaining the Engineer's prior approval. All other adjustments require prior approval from the Engineer.
- B. Minor adjustments are defined as distances not to exceed:
 - 1. 1 foot at grade, floor ceiling, and roof level in any direction in the horizontal plane.
 - 2. 1 foot on walls in a horizontal direction within the vertical plane.
 - 3. Particular attention shall be paid to door swings, piping, ductwork, and structural steel:
 - 4. In general, waste and vent lines, large pipe mains, and ductwork shall be given priority for the locations and spaces shown.
 - 5. In general, electrical lighting fixtures shall be given priority for ceiling space.
 - 6. Where minor location adjustments are required, such adjustments shall be made at no cost to the Owner or project.

3.15 PENETRATIONS, PATCHING, AND PAINTING

- A. Penetrations (openings, holes, chases, sleeves, slots, cuts, etc.):
- B. Properly size and locate penetrations required as construction progresses. For new concrete or masonry, the Contractor shall coordinate, locate, and provide required openings prior to the pouring of concrete or construction of masonry.
- C. Obtain written approval from the Structural Engineer/Architect for penetration of structural elements prior to penetration.
- D. Penetration of concrete and structural elements shall be avoided where possible. Where not possible, penetrations shall be performed in a manner that will not reduce structural element load-carrying capacity or load-deflection ratio.
- E. Penetrations shall be performed by workers qualified and skilled in the trades involved.
- F. Penetrations shall not be exposed on the exterior or in occupied spaces in a manner that would, in the Engineer's opinion, reduce the aesthetic qualities of the structure or result in visual evidence of penetration and patching.

- G. Penetrations shall be constructed using methods least likely to damage elements to be retained or adjoining construction.
- H. Provide temporary support for the work to be penetrated.
- I. In general, where cutting is required, use hand or small power tools designed for sawing or grinding, not for hammering or chopping. Cut holes and slots neatly to required size with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
- J. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring of existing finished surfaces.
- K. Cut through concrete and masonry using a cutting device such as a Carborundum saw or diamond core drill.
- L. Voids around penetrations shall be properly sealed, caulked or grouted as required.
- M. Fire stopping: Penetrations (through and membrane) of fire rated barriers shall be fire stopped and sealed.
- N. The fire rating of the barrier shall be maintained.
- O. Material shall conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.
- P. Existing elements:
 - 1. The Contractor shall be responsible for identifying, locating, and protecting existing embedded conduits, pipe, ductwork, etc. when penetrating existing structures.
 - 2. Cap, valve, plug or seal remaining portions of cut pipes or conduit to prevent entrance of moisture or other foreign matter.
 - 3. The Contractor shall be responsible for repairing and/or replacing existing conduits, pipe, ductwork, etc. damaged by the Contractor during construction of penetrations. Repair and/or replacement shall be at no additional cost to the Owner.
 - 4. Penetrations (and subsequent patching) resulting from the Contractor's failure to properly coordinate penetrations shall be at no additional cost to the Owner.
- Q. Patching:
 - 1. Patching in every instance consists of completing the work to match and blend with the adjoining existing work insofar as methods, materials, colors, and workmanship are concerned
 - 2. Patching shall be performed by workers qualified and skilled in the trades involved.
 - 3. The Contractor shall be responsible for replacing improperly matched, blended, or poorly constructed patches at no additional cost to the Owner.
- R. Painting:

1. Painting shall consist of cleaning, surface preparation, painting (primer, intermediate, and finish) and finishing surfaces and items, new and existing, affected by the work of the Contractor.
2. Surface painting shall match and blend with existing adjoining surfaces.
3. Scratched, chipped, or otherwise marred equipment shall be repainted to match original finish.
4. The areas around penetrations, once sealed, shall be painted.
5. Painting shall be performed by workers qualified and skilled in the trades involved.
6. The Contractor shall be responsible for refinishing and repainting improperly matched, blended, or poorly painted surfaces and items at no additional cost to the Owner.

3.16 HOUSEKEEPING

- A. During the course of construction:
 1. At the conclusion of each day's work, remove empty boxes, crates, and other debris, and sweep clean all work areas affected by the Contractor's work of the day.
- B. At project completion:
 1. Remove all tools and scaffolding.
 2. Equipment and facilities shall be thoroughly cleaned inside and out and residue removed.
 3. Remove temporary labels and adhesives.
 4. Thoroughly vacuum the interior of enclosures to remove debris.
 5. Surplus product, materials and debris shall be cleared from the job site.
 6. The Contractor is solely responsible for the appropriate disposal of all surplus product, materials and debris.

3.17 SUBSTANTIAL COMPLETION

- A. Pre-Substantial Completion Submittal: Three weeks prior to Substantial Completion, the Contractor shall prepare and submit the following:
 1. Station References and Labels Spreadsheet per the requirements of Division 27 05 53 Identification for Communications Systems
- B. Known Exceptions/Deviations List:
 1. A thorough list of known exceptions/deviations (in materials, construction, and/or workmanship) from that specified in the Contract Documents, and for which there was not associated documentation in the form of Change Orders (CO), Construction Change Directives (CCD), Architects Supplemental Instructions (ASI), or responses to a Request for Information (RFI).
 2. The Contractor shall submit the list to the Engineer for review. The Engineer shall review each item and mark as either Accepted or Not Approved.

3. Items marked "Not Approved" shall be corrected by the Contractor to conform with the intent of the Contract Documents at no additional cost to the Owner.
 4. The Contractor shall perform corrective action for "Not Approved" items prior to notifying the Engineer that the work is Substantially Complete.
- C. Notice of Substantial Completion: When the Work nears Substantial Completion, the Contractor shall notify the Engineer in writing the date that the work will be Substantially Complete and ready for review by the Engineer.

3.18 PROJECT CLOSE-OUT

A. Punch List:

1. Once notice of Substantial Completion is received, the Engineer shall visit the site to review the Work, and shall prepare a punch list of items determined to be incomplete, deficient, or otherwise not in compliance with the intent of the Contract Documents.
2. During the review of the Work, if the Engineer finds that the Known Exceptions/Deviations List provided by the Contractor was insufficiently thorough, that the Work is not Substantially Complete, or that deficiencies in the work are excessive, the Engineer will cease review and inform the Contractor that the work is not Substantially Complete. The Contractor shall be responsible for fees incurred by the Engineer for this partial review.
3. The Contractor shall perform corrective action for each item noted in the punch list. When complete, the Contractor shall submit the original punch list with each item initialed attesting to the fact that the item was corrected.
4. If necessary, the Engineer will perform a subsequent review after receipt of the Contractor initialed punch list.
5. Should additional reviews beyond the original punch list review be required of the Engineer due to the Contractor's failure to correct all incomplete, deficient, or non-compliant work, the Contractor shall be responsible for fees incurred by the Engineer for the additional reviews.

- B. Provide O&M Manuals per the requirements of subsection "1.014 Operating and Maintenance (O&M) Manuals" herein.

3.19 FOLLOW UP

- A. After the system(s) and facility have been placed in operation and are in use by the Owner, provide technical assistance for the first two months of operation on a standby basis for troubleshooting, education, and problem solving.

END OF SECTION

SECTION 27 05 26 – GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section provides the minimum requirements for the grounding, bonding and protection for all communication systems included within Division 27 and Division 28.
- B. This section includes the minimum requirements for the equipment and cable installations in telecommunications rooms, server rooms, and communications equipment rooms.
- C. Provide grounding and bonding for all communication system components in accordance with references listed in the “Reference Standards” section of these specifications.
- D. Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.
- E. This section includes minimum requirements for the following:
 - 1. Telecommunications Grounding Busbar (TGB)
 - 2. Telecommunications Main Grounding Busbar (TMGB)
 - 3. Telecommunications Bonding Backbone (TBB)
- F. All cables and related terminations, support and grounding/earthing hardware shall be furnished, installed, wired, tested, labeled, and documented by the telecommunications contractor as detailed in this document.
- G. Product specifications, general design considerations, and installation guidelines are provided in this document. If the bid documents are in conflict, this stricter document shall take precedence. The successful vendor shall meet or exceed all requirements for the cable system described in this document.

1.2 RELATED SECTIONS

- A. Communications Systems (27 00 00)
- B. Security Systems General Requirements (28 05 00)

1.3 SUBMITTALS

- A. Provide product data for the following:
 - 1. Manufacturer’s cut sheets, specifications and installation instructions for all products.

1.4 DEFINITIONS

A. Bonding

1. The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

B. Mesh Common Bonding Network (MCBN)

1. The mesh CBN (MCBN) can be readily utilized for efficient direct bonding of equipment and other apparatus to the grounding system. Such an arrangement provides efficient grounding and inter/intra-unit bonding of metal cabinets, racks and miscellaneous metal objects (especially when they are not powered). Additionally, the MCBN ensures grounding reliability of the equipment in the event the equipment grounding conductor of the serving power circuit is compromised or disconnected during maintenance. Electrostatic charge buildup and dissipation is also greatly aided by the multiple grounding paths of the CBN. See Figure 1.

C. Ground/Earth

1. A conducting connection, whether intentional or incidental, by which an electric circuit or equipment is connected to earth, or to some conducting body of relatively large extent that serves in place of the earth.

D. Retrofit Rack Grounding/Earthing

1. The application of grounding/earthing products and technology where equipment is already deployed and functioning within the equipment rack.

E. Retrofit Cabinet Grounding/Earthing

1. The application of grounding/earthing products and technology where equipment is already deployed and functioning within the equipment cabinet.

1.5 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufactures listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

- B. Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.

- C. Material and work specified herein shall comply with the applicable requirements of:

1. ANSI/TIA-568-C Generic Telecommunications Cabling for Customer Premises
2. ANSI/TIA-569-C Telecommunications Pathways and Spaces

3. ANSI/TIA- 606-B Administration Standard for Telecommunications Infrastructure
4. ANSI/TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
5. CSA C22.1 – Canadian Electrical Code, 2012
6. BICSI – Telecommunications Distribution Methods Manual, 13th Edition, 2014

PART 2 - GENERAL

2.1 GENERAL

- A. All materials shall be UL listed and new, free from damage or defects. Furnish any associated material needed for proper installation of all materials required to complete the project.
- B. All grounding/earthing conductors shall be copper.
- C. Lugs, HTAPs, grounding strips, and busbars shall be UL Listed and made of premium quality tin-plated electrolytic copper that provides low electrical resistance while inhibiting corrosion. Antioxidant shall be used when making bonding connections in the field.
- D. Two-hole lugs shall be used. All lugs shall be irreversible compression and meet NEBS Level 3 as tested by Telcordia. Lugs with inspection windows shall be used in all non-corrosive environments so that connections may be inspected for full conductor insertion
- E. Die index numbers shall be embossed on all compression connections to allow crimp inspection.
- F. Cable assemblies shall be UL Listed and CSA Certified. Cables shall be a distinctive green or green/yellow in color, and all jackets shall be UL, VW-1 flame rated.
- G. Telecommunications Main Grounding Busbar (TMGB)
 1. The primary starting point for the grounding system is the Telecommunications Main Grounding Bus (TGMB). Where practical, it should be located as close as practical to the telecommunications service entrance or Minimum Point of Entrance (MPOE). However, it must also be in close proximity to the building's Main Electrical Ground (MEG) point. The TGMB shall be bonded to the MEG with a Building Conductor for Telecommunications (BCT) equal in size to the building's ground conductor, or up to a maximum of 4/0 AWG. All mating surfaces shall be coated with anti-oxidant compound. The TMGB shall be sized to allow for a minimum of 30% additional capacity.
 2. Outside plant protector blocks shall be bonded to the TMGB along with any shield isolation gap (building side) conductors. All mating surfaces shall be coated with anti-oxidant compound.

3. All equipment and metal structures located in the space with the TGMB/TGB shall be bonded to the TGMB with a minimum of a # 6 AWG. This would include: Electrical Panel Board, Building Steel (if in close proximity), HVAC equipment (if present), Ladder Rack and Cable Tray, Equipment Racks and Cabinets, Conduit and Pipes (except for short "sleeves").

H. Telecommunications Grounding Busbar (TGB)

1. All Telecommunication Spaces shall be provided with a Telecommunications Ground Busbar (TGB). The TGB shall be bonded to either the TMGB or the TBB with a conductor sized in accordance with Figure 1 or by engineered calculations. Only irreversible crimp or exothermic welds shall be used. All mating surfaces shall be coated with anti-oxidant compound. The TGB shall be sized to allow for a minimum of 30% additional capacity.

I. Telecommunication Bonding Backbone (TBB)

1. From the TGMB, a Telecommunication Bonding Backbone (TBB) shall extend to all telecommunications spaces. This conductor shall be sized in accordance with Table 1, or by other engineered calculations. Where possible the TBB should be a single unbroken conductor. If a splice is required, only irreversible crimps or exothermic welds shall be used. Where possible, the TBB should follow the same pathway as the rest of the telecommunication infrastructure. Where two parallel TBBs are used, they shall be connected at the furthest point by a Grounding Equalizer (GE) conductor which shall be sized the same as the largest TBB. In addition, a GE shall be installed at every third floor (if applicable).

J. Rack Bonding Conductor

1. Individual sections of Ladder Rack may be bonded together using a # 6 AWG jumper to minimize the number of connections back to the TMGB/TGB. In normal sized spaces, all racks and cabinets shall be bonded individual with a Rack Bonding Conductor (RBC) to the TMGB/TGB. No "daisy chaining" is permitted. For larger spaces, a Telecommunication Equipment Bonding Conductor (TEBC) may be used, with individual RBCs connected via irreversible crimp connections. Any surface that is painted or coated must be scraped or sanded to bare metal to insure a sound electrical connection. All mating surfaces shall be coated with anti-oxidant compound.

K. Lugs and Crimps

1. Each lug shall have two (1/4" for #6 - 5/8" centers and 3/8" for #2 lugs - 1" centers)

2.2 WALL MOUNT BUSBARS

A. Telecommunications Grounding Busbar (TGB) – 12"

1. Telecommunications Grounding Busbar (TGB) shall be constructed of .25" (6.4 mm) thick solid copper bar.
2. The busbar shall be 2" (50 mm) high and 12" (300 mm) long and shall have 9 attachment points (one row) for two-hole grounding lugs.
3. The busbar shall be pre-assembled with BICSI/ANSI/TIA-607-C hole spacing.

4. Manufacturer: Panduit, Part/Model No. GB2B0306TPI-1

B. Telecommunications Grounding Busbar (TGB) – 24”

1. Telecommunications Grounding Busbar (TGB) shall be constructed of .25” (6.4 mm) thick solid copper bar.
2. The busbar shall be 2” (50 mm) high and 24” (600 mm) long and shall have 19 attachment points (one row) for two-hole grounding lugs.
3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-B and shall accept 6 lugs with 5/8” (15.8 mm) hole centers and 3 lugs with 1” (25.4 mm) hole centers.
4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4” (100 mm) standoff from the wall.
5. The busbar shall be UL Listed as grounding and bonding equipment.
6. The busbar shall be pre-assembled with BICSI/ANSI/TIA-607-C hole spacing.
7. Manufacturer: Panduit, Part/Model No. GB2B0514TPI-1

C. Busbar Label Kit

1. The wall mounted busbar label kit shall include printed tag and one flame retardant cable tie.
2. Manufacturer: Panduit, Part/Model No. LTYK

2.3 Bonding accessories

A. Armored Cable Grounding Kit

1. The armored cable grounding shall be #6 AWG (16mm²) jumper for armored cable diameter up to 0.84” (21.3mm).
2. The armored cable grounding shall be 24” (609.6mm) length.
3. The armored cable grounding shall be factory terminated on one end with LCC6 two-hole copper compression lug and the other end with grounding terminal.
4. The armored cable grounding shall be provided with two each #12-24 and M6 thread-forming screws and a black polypropylene terminal cover.
5. Manufacturer: Panduit, Part/Model No. ACG24K

B. Two Mounting Hole Ground Terminal Block

1. Ground terminal block shall be made of electroplated tin aluminum extrusion.
2. Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.
3. The conductors shall be held in place by two stainless steel set screws.
4. Ground terminal block shall have two 1/4” (6.4 mm) holes spaced on 5/8” (15.8 mm) centers to allow secure two-bolt attachment to the rack or cabinet.
5. Ground terminal block shall be UL Listed as a wire connector.

C. Two-Hole Compressing Lugs

1. Compression lugs shall have two-holes with spacing per standards.

2. Compression lugs shall be manufactured from electroplated tinned copper.
3. Compression lugs shall have two holes spaced on 5/8" (15.8 mm) or 1" (25.4 mm) centers, as stated below, to allow secure two bolt connections to busbars.
4. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0, as stated below.
5. Compression lugs shall be UL Listed as wire connectors.
6. Manufacturer: Panduit, LCC Series

D. HTAPs

1. HTAPs
 - a. HTAPs shall be selected according to AWG size of run and tap conductors.
 - b. Manufacturer: Panduit, HTCT Series
2. HTAP cover
 - a. Clear covers for HTAPs shall be selected according to HTAP being covered.
 - b. Manufacturer: Panduit, CLRCVR series

E. Vertical Grounding Busbar

1. The vertical grounding busbar strip shall be 78.65" (2m) length; .67" (17mm) width; .05" (1.27mm) thickness; provided with .16 oz. (5cc) of antioxidant, one grounding sticker and three each #12-24 x 1/2" and M6 x 12mm thread-forming screws
2. Manufacturer: Panduit, Part/Model No. RGS134-1Y

F. Rack Grounding Jumper Kits

1. Rack Grounding Jumper Kit – 60"
 - a. The 60" (1.52m) length jumper kit shall be used for bonding individual racks or cabinets into grounding backbone.
 - b. The jumper shall be #6 AWG (16mm²) jumper; 45° bent lug on grounding strip side; provided with .16 oz. (5cc) of antioxidant, two each #12-24 x 1/2", M6 x 12mm, #10-32 x 1/2" and M5 x 12mm thread forming screws and a copper compression HTAP* for connecting to a #6 to #2 awg sized bonding backbone.
 - c. Manufacturer: Panduit, Part/Model No. RGCBNJ660P22
2. Rack Grounding Jumper Kit – 72"
 - a. The 72" rack jumper (and cabinet) kits shall be used for smaller TDR (5 bays or less) to bond individual rack or cabinet directly back to wall mounted busbar.
 - b. One 72" length #6 AWG green wire with yellow horizontal stripe.
 - c. Jumper is pre-terminated on one end with LCC6-14JAWH-L and the other end with LCC6-14JAW-L.
 - d. Manufacturer: Panduit, Part/Model No. GJ672UH

G. ESD Wrist Strap

1. ESD Wrist Strap
 - a. Adjustable fabric ESD wrist strap with 6' coil cord, banana plug, 1 mega-ohm resistor and 4mm snap.
 - b. The ESD wrist strap shall be located within reach of all equipment.

- c. Manufacturer: Panduit, Part/Model No. RGEDSDWS
 - d. Works with ESD Port Panduit RGEDSD2-1
- 2. ESD Port for Wrist Strap
 - a. The two-hole ESD port shall have 5/8" hole spacing; provided with an ESD protection sticker, .16 oz. (5cc) of antioxidant, and two each #12-24 x 1/2" and M6 x 12mm thread-forming screws.
 - b. The ESD port for wrist strap shall be located within reach of all equipment.
 - c. The ESD port for wrist strap works with wrist strap Panduit RGEDSDWS.
 - d. Manufacturer: Panduit, Part/Model No. RGEDSD2-1
- H. Bonding Screws
 - 1. Bonding screws shall be Green thread-forming bonding screws for use to mount equipment that does not have a built-in grounding pad (terminal).
 - 2. Manufacturer: Panduit, Part/Model No RGTBSG-C
- I. Antioxidant Joint Compound
 - 1. Oxide inhibiting joint compound shall be utilized for copper-to-copper, aluminum-to-aluminum, or aluminum-to-copper connections.
- J. C-Type, Compression Taps
 - 1. Compression taps shall be manufactured from copper alloy.
 - 2. Compression taps shall be C-shaped connectors that wrap around two conductors forming an irreversible splice around the conductors; installation requires a hydraulic crimping tool
 - 3. Compression taps shall be sized to fit specific size conductors, sizes #2 AWG to 4/0, as stated below.
 - 4. Compression taps shall be UL Listed.
- K. Pedestal Clamp with Grounding Connector
 - 1. Pedestal clamp shall be made from electroplated tinned copper or bronze. Installation hardware will be stainless steel.
 - 2. Pedestal clamps shall be sized to fit a specific size conductor, size #6 and/or 2/0, as stated below.
 - 3. Pedestal clamp installation hardware shall be sized to attach to round and/or square raised access floor pedestals that are 1-1/8" to 1-3/4" in diameter, as stated below.
 - 4. Pedestal clamp shall provide straight (in-line) or cross (intersection) support for up to two conductors.
 - 5. Pedestal clamp shall be UL Listed as grounding and bonding equipment.
- L. Pipe Clamp with Grounding Connector
 - 1. Pipe clamp shall be made from electroplated tinned bronze. Installation hardware will be stainless steel.
 - 2. Pipe clamp shall be sized to fit up to two conductors ranging in size from #6 to 250 MCM; conductors must be the same size.

3. Pipe clamp installation hardware shall be sized to attach to pipes, sizes 1" to 6" (.75" to 6.63" in diameter), as stated below.
4. Pipe clamp shall be UL Listed as grounding and bonding equipment.

M. Equipment Grounding Jumper

1. Equipment Grounding Jumper Kit – 24"
 - a. The equipment grounding jumper kit shall include one 24" long pre-terminated equipment grounding jumper with #10 AWG (6mm²) jumper, bent lug on grounding strip side to straight lug on equipment.
 - b. The equipment grounding jumper kit shall provide .16 oz. (5cc) of antioxidant and two each #12-24 x 1/2", M6 x 12mm, #10-32 x 1/2" and M5 x 12mm thread-forming screws.
 - c. Manufacturer: Panduit, Part/Model No. RGEJ1024PHY
 - d. Jumper will be made with UL Listed components
2. Equipment Grounding Jumper Kit – 36"
 - a. The equipment grounding jumper kit shall include one 36" long pre-terminated equipment grounding jumper, with #10 AWG (6mm²) jumper, bent lug on grounding strip side to straight lug on equipment.
 - b. Provided with .16 oz. (5cc) of antioxidant and two each #12-24 x 1/2", M6 x 12mm, #10-32 x 1/2" and M5 x 12mm thread-forming screws.
 - c. Manufacturer: Model/Part/Model No. RGEJ1036PFY
 - d. Jumper will be made with UL Listed components

PART 3 - EXECUTION

3.1 GENERAL WORKMANSHIP

- A. Provide qualified and skilled workmanship. All installations shall be of the highest quality using proper installation methods and per manufacturer's instructions and industry standards.
- B. A licensed electrical contractor shall perform installation and termination of the main bonding conductor to the building service entrance ground.
- C. Avoid routing grounding/earthing conductors in metal conduits. If the grounding/earthing conductor must be routed through a metal conduit, bond each end of the conduit to the grounding/earthing conductor.

3.2 INSTALLATION

- A. Telecommunication Grounding Busbar (TGB)
 1. The TGB will be grounded/earthed to the Telecommunications Main Grounding Busbar (TMGB).

2. Each TGB shall be bonded to building steel and the electrical panel serving equipment in the telecommunications space.
- B. Rack Grounding Busbar
1. AWG #6 jumpers shall be routed between the electronic equipment and the vertical busbar from each piece electronic device. The busbar shall be connected to the room ground busbar through a home run designed AWG #6 stranded conductor, or larger as required.
- C. Cable Tray/Equipment Racks/Cabinets
1. Attach #6 AWG cable, stranded ground wire with a crimped two-hole lug to the busbar to the following (where applicable):
 2. To cable tray
 3. To each equipment rack using ground lugs.
 4. To each equipment cabinet using ground lugs.
 5. To provide electrical continuity between rack elements, paint piercing grounding washers, shall be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.
 6. Patch panels will be bonded to racks using bonding screws.
 7. Other components as necessary.
- D. Riser Cable
1. Ground all riser cable using grounding spade.
- E. Wall-Mount Busbars
1. Attach busbars to the wall in approved location with appropriate hardware according to the manufacturer's installation instructions.
 2. Conductor connections to the TMGB or TGB shall be made with two-hole bolt-on compression lugs sized to fit the busbar and the conductors.
 3. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
 4. The wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.
- F. Ground Terminal Block
1. Every rack and cabinet shall be bonded to the TMGB or TGB.
 2. Minimum bonding connection to racks and cabinets shall be made with a rack-mount two-hole ground terminal block sized to fit the conductor and rack and installed according to manufacturer recommendations.
 3. Remove paint between rack/cabinet and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.
- G. Pedestal Clamp

1. At minimum, bond every sixth raised access floor pedestal with a minimum #6 AWG conductor to the TMGB or TGB using a pedestal clamp sized to fit the pedestal and the conductor and installed according to the manufacturer's recommendations.
2. If pedestal clamps are used to construct a signal reference grid, bond the signal reference grid to the TMGB or TGB and bond each rack and/or cabinet to the signal reference grid using a compression tap or similar non-reversible bonding component sized to fit both conductors.
3. Remove paint between the pedestal and pedestal clamp, clean surface and use antioxidant between the pedestal and the clamp to help prevent corrosion at the bond.
4. Remove insulation from conductors where wires attach to the pedestal clamp.

H. Pipe Clamp

1. Bond metal pipes located inside the TDR with a minimum #6 AWG conductor to the TMGB or TGB using a pipe clamp sized to fit the pipe and the conductor and installed according to the manufacturer's recommendations.
2. Remove paint between the pipe and pipe clamp, clean surface and use antioxidant between the pipe and the clamp to help prevent corrosion at the bond.
3. Remove insulation from conductors where wires attach to the pipe clamp.

I. Fire Penetrations

1. Bond fire penetration systems (STI EZ Path & Hilti Speed Sleeve) entering or located inside the TDR with a minimum #6 AWG conductor to the TMGB or TGB according to the manufacturer's recommendations.

J. Equipment Ground Jumper Kit

1. Bond the equipment to a vertical rack-mount busbar or ground bar using ground jumper as per the manufacturer's recommendations.
2. Clean the surface and use antioxidant between the compression lugs on the jumper and the rack-mount busbar or ground bar to help prevent corrosion at the bond.

END OF SECTION

SECTION 27 05 28 – PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 General

- A. This section provides the minimum requirements for pathways for all communication systems for sections related to communications included within Division 27 and Division 28.

1.2 Related sections

- A. Communications Systems (27 00 00)

1.3 Summary

- A. This section provides minimum requirements for the OSP and ISP pathways.
- B. Provide all materials and labor for the installation of a pathway system for communications infrastructure.
- C. Firestopping
 - 1. Backboxes
 - 2. Penetrations
 - 3. Conduit
 - 4. Innerduct
 - 5. Sleeves
 - 6. Cable hangers
- D. Firestopping
 - 1. Quality Assurance
 - a. Installer Qualifications
 - 1) Requires an experienced installer who has completed penetration fire stop systems similar in material, design, and extent to that indicated for this project and whose work has resulted in construction with a record of successful in-service performance.
 - 2) Requires an experienced contractor who is qualified by having the necessary experience, staff, and training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell fire stop system products to the contractor or to an installer engaged by the contractor does not in itself confer sufficient qualification on the buyer.
 - b. Source Limitations

- 1) Obtain fire stop systems for each kind of penetration and construction condition indicated from a single manufacturer.
- 2) Products may be in the form of caulk, putty, strip, sheet, or devices that shall be specifically designed to fill holes, spaces, and voids at communications penetrations.
- 3) Firestopping materials shall also provide adhesion to substrates and maintain fire and smoke seal under normal expected movements of substrates, conduits and cables.
- c. Fire Test Response
 - 1) Provide fire stop systems that comply with the following requirements:
 - 2) Fire stopping tests are performed by a qualified testing and inspecting agency such as Underwriters Laboratories (UL), or another agency performing testing and follow-up inspection services for fire stop systems acceptable to the authorities having jurisdiction.
 - 3) Through penetration fire stop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:
 - 4) Through penetration fire stop system products bear classification marking of a qualified testing and inspecting agency.
 - 5) Through penetration fire stop systems correspond to those indicated by reference in UL's "Fire Resistance Directory."
2. Delivery and Handling
 - a. Deliver fire stop system products to the project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying:
 - 1) Product and manufacturer
 - 2) Date of manufacturer
 - 3) Lot number
 - 4) Shelf life, if applicable
 - b. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.
3. Project Conditions
 - a. Environmental Limitations
 - 1) Do not install fire stop systems when ambient or substrate temperatures are beyond the limits permitted by the system manufacturers, or when substrates are wet due to rain, frost, condensation, or other causes.
 - b. Ventilation
 - 1) Ventilate per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.
4. Fire Stopping Products and Accessories
 - a. Provide fire stop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through penetration fire stop systems, under conditions of service and application, as demonstrated by the system manufacturer based on testing and field experience.
 - b. Accessories

- 1) Provide all components that are needed to install fill materials. Use only components specified by the fire stop system manufacturer and approved by the qualified testing and inspecting agency for the systems indicated. Accessories include, but are not limited to, the following items:
 - 2) Permanent forming/damming/backing materials, including the following:
 - 3) Slag-rock/wool-fiber insulation
 - 4) Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state
 - 5) Fire-rated form board
 - 6) Temporary forming materials
 - 7) Substrate primers
 - 8) Collars
 - 9) Steel sleeves
5. Mixing
 - a. For those products requiring mixing before application, comply with the fire stop system manufacturer's written instructions for accurate combination of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for the application indicated.
6. Implementation
 - a. Examination
 - 1) Examine substrates and conditions with installer present to check for: compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
 - 2) Proceed with installation only after unsatisfactory conditions have been corrected.
 - b. Surface Cleaning
 - 1) Clean out openings immediately before installing through penetration fire stop systems. Comply with written recommendations of the fire stop system manufacturer and the following requirements:
 - 2) Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of the fire stop system.
 - 3) Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with the fire stop systems. Remove loose particles remaining from cleaning operation.
 - 4) Remove laitance and form-release agents from concrete.
 - c. Priming
 - 1) Prime substrates where recommended (in writing) by the system manufacturer. Use that manufacturer's recommended products and methods. Confine primers to the areas of bond. Do not allow spillage and migration onto exposed surfaces.
7. The Contractor shall submit a list of firestopping products and procedures. The submittal shall include:

- a. The manufacturer's technical data for each product including product description, specifications including labeling or listing by an agency acceptable to the Owner or Authorized Representative, and storage requirements.
- b. The firestop design documentation shall include type of each penetration, type of building construction being penetrated, the hourly resistance rating of floor, wall, or other partition of building construction and firestop device or system proposed for use.
- c. The manufacturers Installation Procedure sheets that outlines how and which specific products are to be used.

E. Fire Rated Pathway Assembly

1. STI EZ Path

- a. Assembly shall have UL Classification markings
- b. Use only firestop products that have been ASTM E 814 (ANSI/UL1479) tested for specific fire-rated construction conditions conforming to construction assembly type, annular space requirements and fire-rating involved for each separate instance.
- c. Cables passing through fire-rated walls shall pass through fire-rated assemblies which contain an intumescent material that adjusts automatically to cable additions or subtractions.
- d. EZPath (preferred method over conduit sleeves) or metallic conduit sleeves may be used when cable tray has to penetrate fire or smoke barriers.
- e. Use 50% fill ratio to determine the number of metallic sleeves/conduits required. Use EZ Pathway cable capacity charts for the cable capacity for appropriate model device
- f. The assembly shall have an F Rating equal to the rating of the barrier in which the Assembly is installed.
- g. Assemblies shall be capable of allowing a 0 to 100-percent visual fill of cables.
- h. Assemblies shall be of a sufficient size to accommodate the quantity and size of low voltage cables required.
- i. Assemblies shall be provided with steel wall plates allowing for single or multiple Assemblies to be ganged together. Multi-gang plates shall be used where applicable.

2. Hilti Speed Sleeve (CP 653)

- a. Assembly shall have UL Classification markings
- b. Use only firestop products that have been ASTM E 814 (ANSI/UL1479) tested for specific fire-rated construction conditions conforming to construction assembly type, annular space requirements and fire-rating involved for each separate instance.
- c. Cables passing through fire-rated floors or masonry walls shall pass through fire-rated assemblies which contain an intumescent material that adjusts automatically to cable additions or subtractions.
- d. Speed Sleeve (preferred method over conduit sleeves) or metallic conduit sleeves may be used when cable tray has to penetrate masonry fire or smoke barriers.

- e. Use 50% fill ratio to determine the number of metallic sleeves/conduits required. Use Speed Sleeve cable capacity charts for the cable capacity for appropriate model device.
- f. The assembly shall have an F Rating (and T rating for floor penetrations) equal to the rating of the barrier in which the Assembly is installed.
- g. Assemblies shall be capable of allowing a 0 to 100-percent visual fill of cables.
- h. Assemblies shall be of a sufficient size to accommodate the quantity and size of low voltage cables required.

F. EMT Conduit

- 1. Electrical Metallic Tubing shall be hot galvanized steel O.D. with an organic corrosion resistant I.D. coating and shall be produced in accordance with U.L. Safety Standard #797 and ANSI C80.3 and shall be listed by a nationally recognized testing laboratory with follow-up service.
- 2. Each length of tubing shall be labeled containing UL Listing and the letters "EMT" clearly and durably marked once per 10 foot (3.05 m) length,
- 3. The letters "EMT" shall be at a minimum of 1/8 inch (3 mm) high.

G. Backbox

- 1. All backboxes shall be 4 inch square double-gang flush mount box with single gang reducer ring for outlet plate.

1.4 SUBMITTALS

A. Comply with Section 27 05 00 for additional submittal requirements and procedures.

B. Product Data

- 1. Pullbox hardware.
- 2. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
- 3. Miscellaneous components.
- 4. Warning tape.

C. Shop Drawings: Show fabrication and installation details for underground ducts and utility structures and include the following:

- 1. For precast manholes and pullboxes, Shop Drawings shall be signed and sealed by a qualified professional engineer, and shall show the following:
 - a. Construction of individual segments.
 - b. Joint details.
 - c. Design calculations.
 - d. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation.

D. Coordination Detailing Activity Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to scale, and show all bends and location of expansion fittings.

1.5 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the owner or owner representative.
- B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the owner or the owner representative.
- C. Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- D. Material and work specified herein shall comply with the applicable requirements of:
 - 1. ANSI/TIA-568-C Generic Telecommunications Cabling for Customer Premises
 - 2. ANSI/TIA-569-C Telecommunications Pathways and Spaces
 - 3. ANSI/TIA-606-B Administration Standard for Telecommunications Infrastructure
 - 4. ANSI/TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - 5. NFPA 70 – National Electric Code, current edition
 - 6. BICSI – Telecommunications Distribution Methods Manual, current edition

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials shall consist of tray sections, tray fittings, connectors, supports, expansion joints, blind end plates, barrier strips, radius drops, bonding conductors and other incidentals and accessories as required. Provide all incidental and/or miscellaneous hardware not explicitly specified or shown on the Contract Documents that is required for a fully operational and warranted system.

2.2 Outside (OSP) Pathways

A. CONDUIT

1. APPLICATIONS

- a. Conduit and associated fittings shall only be used for applications as permitted by CEC and product listing.
- b. The minimum size of conduit shall be $\frac{3}{4}$ inch unless otherwise specified.

- c. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- d. Underground:
 - 1) Under Slab on Grade (within structure slabs only where approved by Structural Engineer): Use rigid PVC conduit.
 - 2) Exterior, Direct-Buried: Use rigid PVC conduit.
 - 3) Exterior, Embedded within Concrete: Use rigid PVC conduit.
 - 4) Transition to galvanized steel rigid metal conduit where emerging from underground.
 - 5) Provide locating tape 12 in. below grade along all underground conduit routes.
- e. Embedded Within Concrete Walls:
 - 1) Use galvanized steel rigid metal conduit (RMC), intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal (P-RMC), or rigid PVC conduit.
 - 2) Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.
- f. Concealed Within Masonry: Use galvanized steel rigid metal conduit (RMC), intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal (P-RMC), or electrical metallic tubing (EMT).
- g. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit (RMC), intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- h. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC), intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- i. Exposed, Interior, Not Subject to Physical Damage:
 - 1) Use galvanized steel rigid metal conduit (RMC) or intermediate metal conduit (IMC). or electrical metallic tubing (EMT).
 - 2) Locations Not subject to Physical Damage shall include electrical rooms, control rooms, data / telephone rooms, and offices, and protected locations in Processing plant rooms, industrial process, and utilization equipment where conduits are 9 feet above finished grade.
- j. Exposed, Interior, Subject to Physical Damage:
 - 1) Use galvanized steel rigid metal conduit (RMC) or intermediate metal conduit (IMC).
 - 2) Locations subject to Physical Damage areas shall include, but not limited to processing plant rooms, industrial process, and utilization equipment. Conduits for these rooms, 0 to 9 feet above finished grade, or where exposed to damage due to operations and maintenance activity, are considered to be the subject to physical damage.
- k. Exposed, Exterior, outdoor areas: Use galvanized steel rigid metal conduit (RMC), intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal (P-RMC).

2. Products

- a. GALVANIZED STEEL RIGID METAL CONDUIT (RMC)
 - 1) Description: CEC, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
 - 2) Fittings
 - 3) Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 4) Material: Use steel or malleable iron.
 - 5) Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.
- b. INTERMEDIATE METAL CONDUIT (IMC)
 - 1) Description: CEC, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
 - 2) Fittings
 - 3) Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 4) Material: Use steel or malleable iron.
 - 5) Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.
- c. FLEXIBLE METAL CONDUIT (FMC)
 - 1) Description: CEC, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
 - 2) Fittings:
 - 3) Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B,
 - 4) Material: Use steel or malleable iron.
- d. LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)
 - 1) Description: CEC, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
 - 2) Fittings:
 - 3) Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 4) Material: Use steel or malleable iron.
- e. ELECTRICAL METALLIC TUBING (EMT)
 - 1) Description: CEC, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
 - 2) Fittings:
 - 3) Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 4) Material: Use steel or malleable iron.
 - 5) Connectors and Couplings: Use compression (gland).
 - 6) Do not use indenter type or set-screw connectors or couplings.

f. RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- 1) Description: CEC, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- 2) Fittings
- 3) Manufacturer: Same as manufacturer of conduit to be connected.
- 4) Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.
- 5) Paint PVC conduits and fittings exposed to sun light. Paint to be rated for outside usage and color shall be approved by the engineer before application.

g. LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

- 1) Description: CEC, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.
- 2) Fittings
- 3) Manufacturer: Same as manufacturer of conduit to be connected.
- 4) Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

B. PULLBOXES

1. Cast-Metal Boxes: Cast aluminum, with outside flanges and recessed, gasketed cover for flush mounting and with nonskid finish and legend on cover. Unit, when buried, shall be designed to support AASHTO H10 loading for sidewalk and landscaped areas and AASHTO M306 HS-20 for roadways, parking lots and loading docks.
2. Precast Pullboxes: Polymer concrete, monolithically poured walls and bottom, with steel frame and access door assembly as the top of pullbox. Duct entrances and windows shall be located near corners to facilitate racking. Pulling-in irons and other built-in items shall be installed before pouring concrete. Cover shall have nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading for sidewalk and landscaped areas and AASHTO M306 HS-20 for roadways, parking lots and loading docks.
3. Cover Legend: "COMMUNICATIONS", as necessary and as shown on plans.
4. Traffic Hinged Pull Box
 - a. Design
 - 1) 3'-0" x 5'-0" x 48" deep
 - a) Jensen Precast, or approved equivalent
5. Fiber Optic Handhole/Pull Box
 - a. Design
 - 1) 4'-0" x 4'-0" x 4'-0" deep
 - a) Jensen Precast, or approved equivalent
 - b. 2'-0" x 3'-0" x 3'-0" deep
 - 1) Jensen Precast, or approved equivalent

2.3 Inside (ISP) Pathways

A. Firestop Devices - EZ-Path Series 44+

1. Wall Plate – Single Gang
 - a. The single wall plate shall be used to allow a single EZ-Path 44 fire-rated pathway device to be installed in a 6" round opening or 4-1/8" x 4-5/8" opening.
 - 1) Manufacturer: STI, Part/Model No. EZP144W
2. Pathway Device (without Wall Plate) EZ-Path 44+ Fire-Rated
 - a. The pathway device shall be used through walls up to 12" thick.
 - b. Manufacturer: STI, Part/Model No. EZD44S2
3. Wall Bracket/Plate - Multi-Gang
 - a. The wall bracket shall be used between studs up to 24"
 - b. The inside dimensions shall be 20" wide x 4-5/8" high x 6" long.
 - c. Manufacturer: STI, Part/Model No. EZP544W
4. Radius Control Module
 - a. The radius control module shall clip into ends of 44+ series and shall maintain the bend radius of exiting cables.
 - b. The module shall have a min. 1" Bend radius control.
 - c. Manufacturer: STI, Part/Model No. EZRCM44S
5. Extension Module
 - a. The extension modules shall connect to the ends of the 44+ series to increase the assembly length to penetrate barriers up to 24" thick.
 - b. Up to (2) modules can be added to a 44+ series device.
 - c. Manufacturer: STI, Part/Model No. EZD44ES

B. Firestop Devices - EZ-Path Series 33

1. Wall Plate
 - a. The single wall plate shall be used to allow a single EZ-Path 33 fire-rated pathway device to be installed in a 4 in. (102 mm) round opening or 3 in. (76 mm) x 3 in. (76 mm) square opening.
 - b. Manufacturer: STI, Part/Model No. EZP133CW
2. Pathway Device (without Wall Plate) EZ-Path 33 Fire-Rated
 - a. The pathway device shall be used through walls or floors up to 9" thick.
 - b. Manufacturer: STI, Part/Model No. EZD33FWS
3. Wall Bracket/Plate - Multi-Gang
 - a. The wall bracket shall be used between studs up to 24"
 - b. Manufacturer: STI, Part/Model No. EZP*33W
4. Radius Control Module
 - a. The Radius Control Modules (RCMs) snap into the ends of pathways and provide a 1 in. (25 mm) minimum bend radius for cables.
 - b. Manufacturer: STI, Part/Model No. RCM33

C. Firestop Devices - EZ-Path Series 22

1. EZ Path Device (with kit)
 - a. The pathway device (with kit) shall be installed in a 2 in. round opening.
 - b. Manufacturer: STI, Part/Model No. EZD22
- D. Firestop Devices – EZ-Firestop Grommets
 1. Split Grommet for small cable penetrations (up to 0.27 in.)
 - a. Manufacturer: STI, Part/Model No. RFG1
 2. Split Grommet for small cable penetrations (up to 0.53 in.)
 - a. Manufacturer: STI, Part/Model No. RFG2
- E. Firestop Devices – Hilti Speed Sleeve
 1. Pathway Device
 - a. The pathway device shall be used through masonry walls or floors up to 12" thick.
 - b. 2" or 4" model options
 - c. Manufacturer: Hilti, Part/Model No. CP 653
- F. Cable Hangers
 1. J-Hook (1" Cable Support)
 - a. Nonconductive Plenum Rated 2" wide polypropylene Comfort Cradle with Locking Restraint Latch
 - b. UL listed hardware
 - c. UL listed for use in plenums
 - d. Fill capacity for 1" cradle: Up to 21ea CAT5E or 16ea CAT6A. (100% Fill)
 - e. The J-hook shall be TIA/EIA 569 Compliant, UL2043 Approved.
 - f. The J-hook shall be white in color.
 - g. Manufacturer: CEAS, Part/Model No. Stiffy Fig 200/Fig 201
 2. J-Hook (2" Cable Support)
 - a. Nonconductive Plenum Rated 2" wide polypropylene Comfort Cradle with Locking Restraint Latch
 - b. UL listed hardware
 - c. UL listed for use in plenums
 - d. Fill capacity for 2" cradle: Up to 87ea CAT5E or 66ea CAT6A. (100% Fill)
 - e. The J-hook shall be TIA/EIA 569 Compliant, UL2043 Approved.
 - f. The J-hook shall be white in color.
 - g. Manufacturer: CEAS, Part/Model No. Stiffy Fig 200/Fig 201
 3. J-Hook (3-1/2" Cable Support)
 - a. Nonconductive Plenum Rated 2" wide polypropylene Comfort Cradle with Locking Restraint Latch
 - b. UL listed hardware
 - c. UL listed for use in plenums
 - d. Fill capacity for 3-1/2" cradle: Up to 267ea CAT5E or 202ea CAT6A. (100% Fill)
 - e. The J-hook shall be TIA/EIA 569 Compliant, UL2043 Approved.

- f. The J-hook shall be white in color.
 - g. Manufacturer: CEAS, Part/Model No. Stiffy Fig 200/Fig 201
- 4. J-Hook Cable Support Tree
 - a. Tree supports multiple J-hooks.
 - b. J-hook widths vary
 - c. Max load for support rod with footprint: 70#
 - d. Max load for cradle: 50#
 - e. Manufacturer: CEAS, Part/Model No. Stiffy Fig 206
- 5. All Threaded Rod (ATR)
 - a. ATR shall be one continuous piece
 - b. Size: 3/8"
 - c. Threads per Inch: 16
 - d. Standard Finish: Zinc-plated, stainless steel type 304

PART 3 - EXECUTION

3.1 General

- A. No conduit bend shall be greater than 90 degrees.
- B. No length of conduit shall exceed 150 feet and shall not contain more than two 90-degree bends. If either of the criteria cannot be met due to field conditions, then a pull box must be installed to alleviate tension on the cable when it is installed to avoid signal degradation. Pull box must be sized to meet TIA/EIA standards.
- C. Conduit bends should be new, smooth, even, and free of kinks or other discontinuities that may have a detrimental effect on cable installation.
- D. All pull-boxes must be installed in accessible locations, no closer than 4" to the ceiling tile grid and no higher than 24" above the ceiling tile grid, with the cover of the pull-box easily accessible as well. If the cover of the pull-box is located on the side of the pull-box, 18" inches of clearance is required from the pull-box cover to the nearest pipe, duct, conduit, etc.
- E. All communication pathways that penetrate fire-rated barriers must be firestopped in accordance with applicable codes.
- F. Provide fire-stopping material for all conduits used and set aside for future use for low-voltage cabling, including riser and security cables.
- G. Use only materials and methods that preserve the integrity of the firestopping system and its rating.

3.2 INSTALLATION

- A. Ground one or both ends of conduit runs in accordance with all applicable codes and requirements.
- B. Ream all conduit ends and fit them with bushings.
- C. Install pull cord in each conduit run. Tie off pull cord at both ends of the conduit run.

3.3 FIRESTOPPING

A. Installation

- 1. Install through penetration fire stop systems in a manner that complies with the manufacturer's written installation instructions and published drawings for products and applications indicated.
- 2. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of fire stop systems.
- 3. Install fill materials for fire stop systems using proven techniques to produce the following results:
 - a. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve the indicated fire-resistance ratings.
 - b. To assure adherence to substrates through proper application, apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - c. For fill materials that will remain exposed after completing work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

B. Identification

- 1. Identify through penetration fire stop systems with pressure-sensitive, self-adhesive, pre-printed vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each fire stop system installation where labels will be visible to anyone seeking to remove penetrating items or fire stop systems. Warning label shall read:
- 2. "Warning — Through Penetration Fire Stop System — Do Not Disturb. Notify Building Management of Any Damage"
- 3. Date of installation

C. Cleaning and Protection

- 1. Clean off excess fill materials adjacent to openings as work progresses. Use only cleaning materials that are approved by the fire stop manufacturers and use only cleaning materials that do not damage materials in which openings occur.
- 2. Provide final protection and maintain conditions during and after installation that ensure fire stop systems are without damage or deterioration at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out,

remove damaged or deteriorated fire stop immediately, and install new materials to produce systems complying with specified requirements.

D. Delivery, Storage, and Handling

1. Deliver fire stop system products to the project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying:

E. Product and Manufacturer

1. Date of manufacturer
2. Lot number
3. Shelf life, if applicable
4. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

F. Project Conditions

1. Environmental Limitations
 - a. Do not install fire stop systems when ambient or substrate temperatures are beyond the limits permitted by the system manufacturers, or when substrates are wet due to rain, frost, condensation, or other causes.

G. Ventilation

1. Ventilate per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

H. Fire Stopping Products and Accessories

1. Provide fire stop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through penetration fire stop systems, under conditions of service and application, as demonstrated by the system manufacturer based on testing and field experience.

I. Accessories

1. Provide all components that are needed to install fill materials. Use only components specified by the fire stop system manufacturer and approved by the qualified testing and inspecting agency for the systems indicated. Accessories include, but are not limited to, the following items:

J. Permanent forming/damming/backing materials, including the following:

1. Slag-rock/wool-fiber insulation
2. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state
3. Fire-rated form board
4. Temporary forming materials
5. Substrate primers
6. Collars
7. Steel sleeves

K. Mixing

1. For those products requiring mixing before application, comply with the fire stop system manufacturer's written instructions for accurate combination of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for the application indicated.

L. Implementation

1. Examination
2. Examine substrates and conditions with installer present to check for: compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

M. Surface Cleaning

1. Clean out openings immediately before installing through penetration fire stop systems. Comply with written recommendations of the fire stop system manufacturer and the following requirements:
2. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of the fire stop system.
3. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with the fire stop systems. Remove loose particles remaining from cleaning operation.
4. Remove laitance and form-release agents from concrete.

N. Priming

1. Prime substrates where recommended (in writing) by the system manufacturer. Use that manufacturer's recommended products and methods. Confine primers to the areas of bond. Do not allow spillage and migration onto exposed surfaces.

O. Installation

1. Install through penetration fire stop systems in a manner that complies with the manufacturer's written installation instructions and published drawings for products and applications indicated.
2. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of fire stop systems.
3. Install fill materials for fire stop systems using proven techniques to produce the following results:
4. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve the indicated fire-resistance ratings.

5. To assure adherence to substrates through proper application, apply materials so they contact and adhere to substrates formed by openings and penetrating items.
6. For fill materials that will remain exposed after completing work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

P. Identification

1. Identify through penetration fire stop systems with pressure-sensitive, self-adhesive, pre-printed vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each fire stop system installation where labels will be visible to anyone seeking to remove penetrating items or fire stop systems. Warning label shall read:
2. "Warning — Through Penetration Fire Stop System — Do Not Disturb. Notify Building Management of Any Damage"
3. Date of installation

Q. Cleaning and Protection

1. Clean off excess fill materials adjacent to openings as work progresses. Use only cleaning materials that are approved by the fire stop manufacturers and use only cleaning materials that do not damage materials in which openings occur.
2. Provide final protection and maintain conditions during and after installation that ensure fire stop systems are without damage or deterioration at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out, remove damaged or deteriorated fire stop immediately, and install new materials to produce systems complying with specified requirements.

- R. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.4 FIRE-RATED PATHWAY INSTALLATION

- A. Install in locations where indicated on the Contract Drawings, arranged singly or in gangs at the height specified.
- B. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
- C. Apply the factory supplied gasketing material prior to the installation of the wall plates.
- D. Secure wall plates to devices per the equipment manufacturer's recommendations.

3.5 OUTSIDE PLANT

- A. In addition to reference standards, conform with the following:
 1. Distances between OSP underground pull points shall not exceed 500 ft.

2. Underground duct shall be installed a minimum of 24 in. below grade.
3. All underground conduit bends shall have a minimum radius of 10-times the conduit diameter.
4. All 90° bends shall be encased in concrete.
5. No more than two 90° bends, and a total of 180°, shall exist between pull points.
6. Install conduit and duct with minimum slope of 4 in. per 100 ft. (0.33%). Slope conduit and duct toward maintenance vaults and away from building entrances.
7. All underground conduits shall be sealed (duct plugs in empty conduits) to control water flow.
8. For empty 4 in. conduits use Tyco/Jackmoon part number 40D402U
9. For empty 2 in. conduits use Tyco/Jackmoon part number 20D236U
10. All underground PVC conduit shall transition to rigid galvanized metallic conduit for above ground routing.
11. Install fittings to accommodate expansion and deflection.
12. Terminate conduit and duct at maintenance vault entries using end bell.
13. Stagger conduit and duct joints vertically in concrete encasement 6 in. minimum.
14. Use suitable separators and chairs installed not greater than 4 ft. on centers.
15. Secure separators and chairs to trench bottom prior to concrete pour.
16. Band conduits and ducts together before backfilling or placing concrete.
17. Securely anchor conduit and duct to prevent movement during concrete placement.
18. Underground conduit shall terminate on end walls of maintenance vaults only (no side wall use is allowed).
19. Provide cable racking equipment in all maintenance vaults.
20. All underground conduit utility separation distances shall comply with IEEE C2 (National Electrical Safety Code).
21. All separation distances and clearances for overhead lines shall comply with IEEE C2 (National Electrical Safety Code).
22. Install drains in maintenance vaults and connect to 4 in. pipe terminating in 1/3 cu. yd. crushed gravel bed
23. Each underground conduit shall have a minimum 3/8 in. polypropylene pull rope installed.
24. A mule tape with footage markers shall be installed in a minimum of one conduit per duct back section.
25. Swab (clean) and proof (certify) prior to sealing.
26. Reconditioning of Surfaces
27. Provide reconditioning of surfaces to return site to original condition.
28. Penetrations
29. Caulk and seal cable access penetrations in walls, ceilings and other parts of the building.
30. Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings.

3.6 ADJUSTING AND CLEANING

- A. Clean up spills of liquid components.
- B. Neatly cut and trim materials as required.
- C. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.

END OF SECTION

SECTION 27 05 53 – IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions, and requirements of other divisions apply to the work of this section.
- B. In the event of any conflicting requirements, the most stringent requirement will apply.

1.2 SUMMARY

- A. This Section includes requirements for communications infrastructure system:
 - 1. Testing
 - 2. Identification and Administration.

1.3 RELATED SECTIONS

- A. Communications Systems (27 00 00)

1.4 SUBMITTALS

- A. Provide submittal information for the following submittal sections as described below:
- B. Other information:
 - 1. Testing (see “Part 2 – Products: testing” herein):
 - 2. Provide a list of proposed test equipment for use in verifying the installation of the communications cabling system.
- C. Provide for each testing device:
 - 1. Manufacturer and product number.
 - 2. Manufacturer documentation showing date and outcome of last re-calibration. Testing device shall have been re-calibrated within the manufacturer’s recommended recalibration period.
 - 3. Manufacturer documentation showing software revision. Software revision shall be most current revision available for the device and shall be based upon the most current TIA/EIA testing guidelines.
 - 4. Patch cords and other specialized components.
 - 5. Provide proposed test result forms.
 - 6. Provide the calculated optical fiber cable loss budget for each optical fiber cable in the system (see “Part 3 – Execution: Testing” herein).

- D. Identification and administration (see “part 2 – materials: identification and administration” herein):
1. Provide a list of proposed hand-carried or computer software based identification/label makers, and a list of proposed materials for identifiers/labels.
 2. Provide actual samples of labels to be created for each system component to be labeled.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. The following products shall be used for labeling:
1. Computer Label Software - Easy-mark labeling software for PC, supplied on USB flash drive for preprinting communications labels on laser/inkjet printer. Part/Model No. Panduit PROG-EM2GO
 2. Horizontal Cable - 2" x 1.5" Self-Laminating Laser Labels, 1000 per pack. Part/Model No. Panduit LJSL7-Y3-1
 3. Category Cable & Patch Cords - Turn-Tell labels for Category 5e/6A cable and patch cords. Labels rotate and slide along cables after Installation for visibility from any angle and allow repositioning on the wire/cable to align legends for improved aesthetics. Eliminate the need to disconnect wire or replace label in the event of re-termination. Part/Model No. Panduit R100X150X1J
 4. Fiber Patch Cords - White cable identification sleeve for 3mm duplex fiber cable, 1-inch-long, 100 per pack, use with labels: S100X225YAJ (Laser/Inkjet); R100X225X1J/S100X225VAC (LS8E Hand-held printer), S100X225VATY or S200X225VATY (Thermal Transfer Printer). Part/Model No. Panduit NWSLC-7Y
 5. Patch Panel Labels - Patch panel labels for use with Easy-Mark software and laser/ink jet printer. Part/Model No. Panduit C261X035Y1J
 6. Faceplate Labels - Single Gang, Faceplate labels for single gang stainless or sloped plastic-use with Easy-Mark software and laser/Ink jet printer. Part/Model No. Panduit C195X040Y1J
 7. Faceplate Labels - Double Gang, Faceplate labels for double gang stainless - use with Ease-Mark software and laser/ink jet printer. Part/Model No. Panduit C288X040Y1J
 8. Fiber Cable Labels - Cable label for indoor/outdoor tight-buffered armored fiber optic cable. For use with Easy-Mark software and ink jet printer. Part/Model No. Panduit S100X650YAJ
 9. Busbar Labels - 1" high, white, vinyl tape labels for labeling grounding busbars, racks, cabinets, and pathways. For use with laser/inkjet printer. Part/Model No. Panduit C200X100FJJ
 10. Modular Faceplate Label - Modular faceplate patch panel labels - use with PanTher handheld labeler. Part/Model No. Panduit C261X035Y1C
 11. Faceplate Label Cassette - Single gang, faceplate labels for single gang stainless - use with PanTher handheld labeler. Part/Model No. Panduit C195X040Y1C

12. Faceplate Label Cassette - Double gang, faceplate labels for double gang stainless - use with PanTher handheld tester. Part/Model No. Panduit C288X040Y1C
13. Fiber Cable Label Cassette - Cable label for indoor/outdoor right-buffered armored fiber optic cable - use with PanTher LS8E handheld labeler. Part/Model No. Panduit S100X650VAC
14. Fiber Patch Cord Sleeve Label - Label for labeling fiber jumpers - use with PanTher LS8E handheld labeler. Part/Model No. Panduit S100X160VAC
15. Fiber Patch Cord Sleeve - Turn-Tell sleeve for fiber jumpers, use label above.
16. Busbar Label Cassette - 1" high, continuous black on white, vinyl tape labels for labeling racks, cabinets, and pathways - use with PanTher LS8E handheld labeler. Part/Model No. Panduit T100X000VPC-BK
17. Hand Held Labeler - Panduit PanTher hand-held label printing system kit. USE FOR LABELS THAT MUST BE PRINTED ON THE JOB SITE. Part/Model No. Panduit LS8EQ-KIT-ACS
18. Cable Label Cassette - Fast loading P1Labelcassette includes both label material and ribbon to make changing labels easy. Part/Model No. Panduit R100X150V1C

PART 3 - EXECUTION

3.1 TESTING

1. Testing of the systems shall be in accordance with the manufacturer's recommendations and with the Governing Requirements.
 - a. Test reports shall be complete and in accordance with the appropriate Governing Requirements.
 - b. Where testing discloses deficiencies in the work, the Contractor shall rework, repair, or replace equipment and systems found deficient. The Contractor shall continue remedial measures and retesting until satisfactory results are obtained. Remedial measures and retesting shall be at no additional cost to the Owner.
 - c. Testing of product or equipment prior to installation shall include performance testing to establish the applicability of equipment for its intended purpose. The Contractor shall:
 - d. Establish the required test procedures from required Governing Requirements and manufacturer's recommendations.
 - e. Provide necessary test equipment, power, and consumables to perform the test.
 - f. Notify the Engineer of test schedule(s) at least one week in advance.
 - g. Provide test result documentation to the Engineer.
 - h. Final testing and start-up of product, equipment, and systems shall include establishing proper capacity, operation, maintenance, and compliance with Governing Requirements. The Contractor shall:
 - 1) Provide the services of manufacturer's representatives for systems to be tested and started up.
 - 2) Perform commissioning test on all low voltage systems to ensure compatibility of Integrated Systems.

- 3) Establish the required test procedures from required Governing Requirements and manufacturer's recommendations.
- 4) Provide necessary test equipment, power, and consumables to perform the test.
- 5) Notify the Engineer of test schedule(s) at least one week in advance.
- 6) Perform tests and start-up functions.
- 7) Provide documentation of test results and fully operational systems to the Engineer.
- 8) Test records shall be provided on a form approved by the Engineer.

END OF SECTION

SECTION 27 11 00 – COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Provide labor, materials, and equipment for the complete installation of work called for in the Contract Documents.
 - 2. Minimum requirements for equipment and cable installations in telecommunications equipment room (TEC), Telecommunications Distribution Room (TDR's) and entrance facilities.

1.2 SUBMITTALS

- A. Provide product data for the following:
- B. Manufacturer's data/cut sheets, product drawing/specifications and installation instructions for all products (submit with bid).

1.3 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the owner or owner representative.
- B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the owner or the owner representative.
- C. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- D. Material and work specified herein shall comply with the applicable requirements of:
 - 1. ANSI/TIA-568-C Generic Telecommunications Cabling for Customer Premises
 - 2. ANSI/TIA-569-C Telecommunications Pathways and Spaces
 - 3. ANSI/TIA- 606-B Administration Standard for Telecommunications Infrastructure
 - 4. ANSI/TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - 5. NFPA 70 – National Electric Code, current edition

6. BICSI – Telecommunications Distribution Methods Manual, current edition
7. NEMA – VE-1 – Metal Cable Tray Systems, 2002
8. NEMA – VE-2 – Metal Cable Tray Installation Guidelines, 2001

PART 2 - PRODUCTS

2.1 EQUIPMENT RACKS

A. Floor Mounted Cabinet

1. Manufacturer: Chatsworth
2. Parts:
 - a. Z4-11U-113C-C12
 - b. 14480-C00
 - c. Provide all other accessories required for complete installation.

B. Wall Mounted Cabinet

1. Manufacturer: Chatsworth
2. Parts:
 - a. 11996-736
 - b. 40972-001 (2 per cabinet)
 - c. Provide all other accessories required for complete installation.

2.2 CABLE MANAGEMENT

A. Horizontal Wire Manager – 2U - Front Only

1. Horizontal cable manager 1 RU, front/rear.
2. The horizontal wire manager dimensions shall be 1.7"H x 19.0"W x 8.9"D.
3. Manufacturer: Panduit, Part/Model No. WMPHF2E

B. Horizontal Wire Manager – 2U - Front/Rear

1. The horizontal cable manager shall be dual-sided.
2. The horizontal cable manager dimensions shall be front/rear 3.5" high x 20.2" wide x 8.9" deep (89mm x 513mm x 226mm).
3. The horizontal cable manager shall include extended front covers and two bend radius clips.
4. The horizontal cable manager shall have ABS material and color black.
5. Manufacturer: Panduit, Part/Model No. WMPH2E

2.3 RACEWAY

A. Metal Cable Runway (Ladder Rack)

1. Provide metal cable runway to affix tops of racks to walls, to route cable from walls to racks within the TEC/TDRs, and in locations shown on the Drawings. Cable runway shall be sized and installed as shown on the Drawings. Cable runway shall be complete with all fittings including but not limited to splice kits, cable radius drop-outs, radius bends, protective end caps, support brackets, foot kits, vertical wall brackets, wall angles, grounding hardware and other incidental and miscellaneous hardware required for a complete cable runway system.
2. Cable Runway – 12" W
 - a. The cable runway shall be 12" wide, "Universal".
 - b. The cable runway dimensions are 3/8" (9.5mm) x 1-1/2" (38.1mm) steel tube welded rungs spaced 12" (305mm) on center.
 - c. The cable runway shall be UL classified.
 - d. The cable runway shall be flat black powder coat.
 - e. Manufacturer: Cooper B-Line, Model/Part No. SB17U12BFB
3. Cable Runway – Hold-Down Clamp Kit
 - a. The vertical cable runway bracket kit shall include two (2) wall clamps.
 - b. The clamp kit material shall be 11 Ga. (3.0mm) ASTM A570 structural steel.
 - c. The clamp kit finish shall be Flat Black Powder Coat (FB).
 - d. Manufacturer: Cooper B-Line, Model/Part No. SB2114AFB
4. Cable Runway – End Cap
 - a. The end caps are used for protective covering for stringer ends of cable runway.
 - b. The end caps shall meet UL 94 Flame Resistance requirement.
 - c. The end cap material shall be Black PVC Plastic.
 - d. Manufacturer: Cooper B-Line, Model/Part No. Cooper B-Line, SB110A1B
5. Cable Runway - 90° Junction-Splice Clamp and Kit
 - a. The cable runway kit shall be UL classified file number E60548.
 - b. The cable runway kit material shall be ASTM A570 structural steel with Black Zinc (BZ) finish.
 - c. The cable runway kit shall include two (2) clamps and hardware.
 - d. Manufacturer: Cooper B-Line, Model/Part No. SB2101ABZ.
6. Cable Runway – Butt-Splice Clamp and Kit
 - a. Cable Runway kit shall be UL classified file number E60548.
 - b. The cable runway kit includes two (2) clamps and hardware.
 - c. The cable runway shall material shall be ASTM A570 structural steel with Black Zinc (BZ) finish.
 - d. Manufacturer: Cooper B-Line, Model/Part No. SB2107BZ
7. Cable Runway - Butt-Swivel Splice Kit,
 - a. UL classified.
 - b. Black.
 - c. Cooper B-Line, SB21110ABZ
8. Cable Runway - Threaded Rod Cover
 - a. The threaded rod cover shall be used to protect cabling from the all threaded rod.
 - b. The threaded rod cover shall be UL-94 VO material for flame resistance.

- c. The threaded rod cover material shall be PVC and gray color finish.
 - d. Manufacturer: Cooper B-Line, SB3015/ 8X72PVC
9. Cable Runway - Radius Drop-Out
- a. The radius drop-out shall be used for cable to exit from side of cable runway stringer.
 - b. The radius drop-out will fit either 3/8" (9mm) x 1 1/2" (38mm) or 2" (51mm) stringers.
 - c. The radius drop-out material shall be 14 ga. (1.9mm) ASTM A36 steel and finish shall be Flat Black Powder Coat (FB)
 - d. Manufacturer: Cooper B-Line, SB2129SD12FB
10. Cable Runway - Channel Rack-to-Runway Attachment Kit
- a. The kit shall be 3" upright network equipment rack top plate runway support kit for use to secure 15" to 18" wide runway cable runway (in parallel or perpendicular arrangement) to top angles of network equipment rack.
 - b. The kit shall include (1) mounting plate and (4) "J" bolts with 5/16"-18 hardware.
 - c. The channel material shall be ASTM A36 structural steel and finished Flat Black Powder Coat (FB).
 - d. Manufacturer: Cooper B-Line, SB213318FB
11. Runway Drop-Out - Radius
- a. The steel runway drop-out shall be used to provide a smooth radius for cable exit.
 - b. The drop-out shall be 4" (102mm) cable bend radius.
 - c. The drop out material shall be 18 Gauge (1.2mm) ASTM A569 steel and finish Flat Black Powder Coat (FB).
 - d. The drop out includes cable tie down holes and self-drilling screws.
 - e. Manufacturer: Cooper B-Line, SB2129U12FB and SB2129U18FB. SB2129 Series fits channel or tube rungs 1/2" (13mm) x 1" (25mm); SB2129U Series fits rungs 3/8" (9mm) x 1 1/2" (38mm).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and tighten high strength bolts to the snug tight condition, in conformance with AISC Specification for Structural Joints using ASTM A325 or A490 Bolts. If Tension Control Bolts or Load Indicator Bolts are used, bolts shall be installed following recommendations of manufacturer. Hardened steel, round, flat washer shall be used under each nut and bolts shall be tightened until wrench twists of spliced ends.

END OF SECTION

SECTION 27 13 00 – COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for the installation of a TIA/EIA standard inside (ISP) and outside (OSP) communications cabling systems.
2. Reference the Construction Drawings for further requirements. In the event of any conflicting requirements, the most stringent requirement will apply.

1.2 RELATED SECTIONS

- A. Communications Systems (27 00 00)
- B. Communications Horizontal Cabling (27 15 00)

1.3 SUBMITTALS

- A. Provide submittal information for the following submittal sections as described below:
 1. Product Data
 - a. Shop Drawings
 - b. Cable and conduit routing and Grouping Plan

PART 2 - PRODUCTS

2.1 SUMMARY

- A. Communication cabling system components shall be sourced (manufactured) by formally partnered Manufacturers (collectively referred to as the “Manufacturer”). Products shall not be intermixed between different manufacturers unless the Manufacturer of the chosen communications cabling system has listed (in writing) another manufacturer’s component as an “Approved Alternative Product” and will warrant the “Approved Alternative Product” as part of the Manufacturer’s extended Warranty.
- B. All cabling products shall be engineered “end-to-end” (i.e. the system and all of its components shall be engineered to function together as a single, continuous transmission path).
- C. The Contractor shall physically verify the following materials on site, prior to purchase and delivery of the materials:

1. Lengths of conduit and/or pathway are to be used for routing backbone cabling. Precut materials of insufficient length are the sole responsibility of the Contractor.
2. Fill ratio and overall suitability of raceway for installation of inside plant cabling: The Contractor shall promptly notify the Engineer of potential overfill, potential for installation problems due to overfill, or raceway which may be otherwise deemed by the contractor unsuitable for use, and shall await the Engineer's direction prior to purchase and delivery of the materials.

2.2 OUTSIDE PLANT BACKBONE CABLING

- A. General: Cable installed home-run from IDF to MDF as shown on the Drawings, shall be Plenum (CMP, OFCP) rated unless installed in conduit from termination point to termination point. Cables shall be manufactured by the selected communications cabling Manufacturer. Provide cable in types, sizes, and quantities as shown on the Drawings. All cables of the same type (Cat 5e, Cat 6A UTP, 50µm MM, 9µm SM etc.) shall be of the same color – multiple colors of the same cable type are not acceptable.

B. Single-mode OS2 Fiber Optic Cable

1. The fiber cable shall be a 9/125µm (OS2) single-mode indoor/outdoor loose-tube interlocking armored cable.
2. The fiber cable shall be six (6) strand.
3. The fiber cable shall be suitable for indoor/outdoor environments.
4. The fiber cable shall be Plenum (OFCP)
5. The fiber cable material shall be PVC.
6. Acceptable Manufacturers: Panduit, Corning, Commscope

C. FIBER OPTIC PANELS

1. 4U Rack-Mount Enclosure
 - a. 4-Rack Units
 - b. The fiber optic housing shall be 4-rack (4U) units that holds up to 12 adapter panels.
 - c. The patch panel dimensions shall be 6.98" H x 17.60" W x 16.30" D.
 - d. Manufacturer: Panduit, Part/Model No. FCE4U
2. 4U Rack-Mount Enclosure
 - a. 4-Rack Units
 - b. The fiber optic housing shall be 4-rack (4U) units that holds up to 12 adapter panels or splice cassettes.
 - c. The patch panel dimensions shall be 6.94" H x 18.84" W x 16.77" D.
 - d. Manufacturer: Corning, Part/Model No. CCH-04U
3. 1U Rack-Mount Enclosure
 - a. 1-Rack Units
 - b. The fiber optic housing shall be 1-rack (1U) units that holds up to 3 adapter panels.
 - c. The patch panel dimensions shall be 1.74" H x 17.00" W x 14.20" D.

- d. Manufacturer: Panduit, Part/Model No. FRME1U
- 4. 1U Rack-Mount Enclosure
 - a. 1-Rack Units
 - b. The fiber optic housing shall be 1-rack (1U) units that holds up to 2 adapter panels or splice cassettes.
 - c. The patch panel dimensions shall be 1.7" H x 18.84" W x 16.77" D.
 - d. Manufacturer: Corning, Part/Model No. CCH-01U
- 5. Wall Mount Housing
 - a. The fiber optic wall mount housing that holds up to 2 adapter panels.
 - b. The panel dimensions shall be 7.4" H x 16.1" W x 4.2" D.
 - c. Manufacturer: Corning, Part/Model No. WCH-02P
- 6. Fiber Storage Reel: 24"
 - a. The fiber storage reel shall be a 24-inch fiber optic reel.
 - b. The fiber storage reel shall have the capacity to hold up to 50 feet of 2-fiber 50/125 mm optical fiber cable or 50 feet of Cat 6A cable.
 - c. The storage ring materials shall be 16-gauge sheet metal.
 - d. The storage ring dimensions are: 24" diameter, 3.5" wide.
 - e. Mounting: Surface mounts to wall (#8x3/4" wood screws included).
 - f. Standards: ANSI/TIA-568-C
 - g. Manufacturer: Leviton, Part/Model No. 48900-OFR

2.3 SPLICE CASSETTES FOR SINGLEMODE (OS2) FIBER CABLE

- A. All SM fiber optic cable shall be terminated via fusion splices to a SM OS2 splice cassette.
 - 1. CCH Pigtailed Splice Cassette, 12-F, loaded with LC APC duplex, Single-mode (OS2), single-fiber (250 μ m) fiber optic adapters, color Green.
 - 2. Manufacturer: Corning, Part/Model No CCH-CP12-B3-P00RE

2.4 FIBER OPTIC PANELS

- A. Fiber Optics Adapter Plates
 - 1. 12-F OM4 LC fiber optic adapter panel, filled with six LC duplex multimode fiber optic adapters, color Aqua.
 - 2. Manufacturer: Panduit, Part/Model No. FAP6WAQDLCZ
- B. Fiber Optics Adapter Plates
 - 1. 12-F SM LC fiber adapter panel, OS1/OS2, filled with six LC duplex singlemode fiber optic adapters, color Blue.
 - 2. Manufacturer: Panduit, Part/Model No. FAP6WBUDLCZ
- C. Fiber Optics Adapter Plates
 - 1. 12-F OM4 LC fiber adapter panel, filled with six LC duplex singlemode fiber optic adapters, color Aqua.

2. Manufacturer: Corning, Part/Model No. CCH-CP12-E4

D. Fiber Optics Adapter Plates

1. 12-F OS2 LC fiber adapter panel, filled with six LC duplex singlemode fiber optic adapters, color Blue.
2. Manufacturer: Corning, Part/Model No. CCH-CP12-A9

E. Fiber Optics Adapter Plates

1. 24-F OM4 LC fiber adapter panel, filled with twelve LC duplex singlemode fiber optic adapters, color Green.
2. Manufacturer: Corning, Part/Model No. CCH-CP24-E4

F. Fiber Optics Adapter Plates

1. 24-F OS2 LC fiber adapter panel, filled with twelve LC duplex singlemode fiber optic adapters, color Blue.
2. Manufacturer: Corning, Part/Model No. CCH-CP24-A9

G. Fiber Storage Reel: 24"

1. The fiber storage reel shall be a 24-inch fiber optic reel.
2. The fiber storage reel shall have the capacity to hold up to 50 feet of 2-fiber 50/125 mm optical fiber cable or 50 feet of Cat 6A cable.
3. The storage ring materials shall be 16-gauge sheet metal.
4. The storage ring dimensions are: 24" diameter, 3.5" wide.
5. Mounting: Surface mounts to wall (#8x3/4" wood screws included).
6. Standards: ANSI/TIA-568-C
7. Manufacturer: Leviton, Part/Model No. 48900-OFR.

2.5 PERFORMANCE

- A. At a minimum, the communications cabling system shall support data network protocols/services at rates up to 10 Gbps. Fiber to 10Gbps. It shall support 10 Mb, 100 Mb, 1 Gb, and 10 Gb Ethernet, ATM (at OC-3 and OC-12) and other network protocols.

2.6 PATCH PANELS

- A. Fiber Patch Panels: Patch panels shall be used to terminate the fiber backbone cables and shall be sized (port/fiber count and rack units) as shown on the Drawings. Fiber patch panels shall consist of enclosures pre-assembled with connector panels, blank connector panels (for unused connector slots), strain relief, rack or wall mountable as shown on the Drawings. Enclosures/housings shall be sized to accommodate 100% of fiber strands installed. Fiber patch panels shall be complete with fiber optic receptacle adapters and with all incidental materials necessary for mounting.
- B. Cable Support Bar/Strain Relief: Provide per manufacturer recommendations.

2.7 CONNECTORS

- A. Fiber Connectors: Fiber connectors shall be LC connectors. Fiber connectors shall meet or exceed the transmission requirements for connecting hardware as specified in the ANSI/TIA 568-C standards.

2.8 BACKBONE CABLE

- A. General: Cable installed home-run from IDF to MDF as shown on the Drawings, shall be Plenum (CMP) rated unless installed in conduit from termination point to termination point. Cables shall be manufactured by the selected communications cabling Manufacturer. Provide cable in types, sizes, and quantities as shown on the Drawings. All cables of the same type (Cat 5e, Cat 6A UTP, 50µm MM, 9µm SM etc.) shall be of the same color – multiple colors of the same cable type are not acceptable.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall pay particular attention to and comply with the applicable portions of the following:
 - 1. TIA/EIA-568-C: Commercial Building Telecommunications Cabling Standard
 - 2. TIA/EIA-606-A: Administration Standard for Commercial Telecommunications Infrastructure
 - 3. J-STD-607-B: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - 4. TIA/EIA-455: Fiber Optic Test Standards
 - 5. TIA/EIA-526: Optical Fiber Systems Test Procedures
 - 6. IEEE 802.3 (series): Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit and 802.3ae 10 Gigabit Ethernet Standard
 - 7. BICSI: BICSI Telecommunications Cabling Installation Manual
 - 8. Manufacturer Recommendations and Installation Guidelines
- B. Connectors:
 - 1. The Contractor shall visually check fiber connectors and/or splices after connectorization and/or splicing with a minimum 200x magnification microscope to ensure that no physical damage has occurred during the installation process.
 - 2. Fiber splices shall be fusion spliced and shall be required for all single mode fiber strands. Mechanical splices are not acceptable. Each fusion splice shall be protected in a splice tray or similar protective device that is designed to mount within the enclosure. Bare/stripped optical fiber strands shall be protected with a heat shrink or silicon adhesive to prevent exposure to moisture.
- C. Cable:

1. General (applicable to all cable types):
 - a. Cable shall be installed in strict compliance with the manufacturer's recommendations.
 - b. Maintain separation from other conductors (power, fire alarm, etc.) per NEC requirements and TIA/EIA standards.
 - c. The bending radius and pull strength requirements of all cable as detailed in the TIA/EIA standards and the manufacturer's installation recommendations shall be strictly observed during handling and installation.
 - d. Pull cables simultaneously where more than one cable is being installed in the same raceway.
 - e. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation (Polywater, or approved equal).
 - f. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cable or raceway.
 - g. Cable jackets shall not be twisted during installation. Cables showing evidence of twisting shall be replaced at no additional cost to the Owner, regardless of the outcome of cable testing.
 - h. Cable shall be installed in a continuous (non-spliced) manner unless otherwise indicated.
 - i. Cable installed in conduit, basket tray and/or ducts:
 - 1) Fill ratios shall not exceed NEC requirements.
 - 2) Cable shall not be pulled into conduit/ducts until the conduit/duct ends have been prepared for cable installation (i.e. reamed to eliminate sharp edges and insulated throat bushings installed). Cables pulled into conduit/ducts prior to conduit/duct end preparation shall be replaced at no additional cost to the Owner.
 - 3) Reinstall pull-wires in conduits and ducts after use to facilitate future addition of cables.
 - j. Cable installed in cable tray/ladder rack:
 - 1) Cable shall not be attached to the cable tray (i.e. cable shall be left "loose") with the exception of cable installed in cable tray (cable runway) within telecommunications rooms (see "Cable in telecommunications rooms" below).
 - 2) Cable shall be laid in tray in such a way as to present a neat and professional appearance.
 - 3) For cable tray serving both backbone (riser) and horizontal cabling, install cable in cable tray in such a manner that backbone cabling does not overlap with horizontal cabling – reserve approximately one-fourth of the space in the tray for backbone cabling and the remaining three-fourths for horizontal cabling.
 - 4) Where cables in cable trays are required to maintain specific distances between each other, they shall be firmly secured to maintain this distance at fire rated penetrations.
 - k. Cable not installed in conduits/ducts or cable tray:

- 1) Cables shall be strapped, fastened for support. Staples and/or tie wraps are not acceptable:
 - a) Straps, fasteners shall not be over-tightened. Cables showing evidence of over-tightening shall be replaced at no additional cost to the Owner, regardless of the outcome of cable testing.
 - b) Straps, fasteners installed in plenum spaces shall be plenum rated.
 - c) Reusable Velcro hook and loop style cable straps/fasteners shall be used within telecommunications rooms. The use of plastic tie wraps is not acceptable on any portion of the installation (see "Cable in telecommunications rooms" below).
 - d) Cables shall be bundled by application (horizontal or backbone) and by cable type (Cat 5e, Cat 6A UTP, MM, SM Fiber, etc.). Cable applications and types shall not be intermixed within a bundle.
- l. Cables in suspended cable runs shall be supported at varying intervals. Cable spans shall be limited to 5 feet or less, and the length of spans shall vary along the cable path (i.e. a given span should not be exactly the same length as the span preceding or following it – "exact" spans can degrade cable performance).
- m. Cable installed on exposed surfaces or structural members shall be installed parallel and perpendicular to the surfaces. Surface contours shall be followed wherever possible. Cables shall be attached to surfaces at intervals not to exceed 3 feet.
- n. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc. – with the exception of ceiling support anchors) is not acceptable.

D. CABLE IN TELECOMMUNICATIONS EQUIPMENT/DATA ROOMS:

1. Cable straps: Install per Section 27 11 00 – Communications Equipment Room Fittings.
2. Cable on backboards:
 - a. Lay and dress all cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings.
 - b. Cable shall be routed as close as possible to the ceiling, floor, sides, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.
 - c. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Secure all similarly routed and similar cables together and attach to D-rings vertically and/or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.

E. Cable Slack

1. Provide cable slack (service loops) at cable ends (both ends) to accommodate future cabling system changes.
2. Provide slack length as follows:
 - a. For fiber: Provide a minimum of 25 feet.

- b. For copper and coaxial: Provide a minimum of 25 feet.
- F. Fiber Cable:
 - 1. Half the quantity of installed singlemode fiber optic strands shall be connectorized. The unterminated fiber strands shall be labeled, coiled, and protected in place for future use.
- G. Cable assemblies (patch cords) and cross-connects:
 - 1. Provide 100% cable assemblies required for a complete system.
- H. Warranty
 - 1. Contractor shall provide a minimum of 25-year warranty for each backbone system installed.
 - 2. Contractor must be adequately trained by system manufacturer.
 - 3. Contractor must have at least 5 year's installation experience in such manufacturer system being installed.

END OF SECTION

SECTION 27 15 00 – COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The requirements of the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, AND DIVISION 01 of the Specifications apply to the Work of this Section.
2. Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.

1.2 RELATED SECTIONS

A. Communications Systems (27 00 00)

1.3 SYSTEM DESCRIPTION

A. Structured Cabling

1. Furnish and install complete permanent link Structured Cabling System (SCS). The SCS shall serve as a vehicle for transport of data, video, and voice telephony signals throughout the network from designated demarcation points to outlets located at various workstations and other locations as indicated on the contract drawings and described herein.
2. Wiring utilized for data and voice communications shall originate at Owner provided networking equipment either in vertical equipment racks located at the Telecommunications Equipment/Data (TEC/TDR) Rooms. Telecommunications Service Outlets (TSO) shall be furnished, wired and installed by the SCS system contractor. All cables and terminations shall be identified at all locations.
3. All cables shall terminate in an alphanumeric sequence at all termination locations.
4. All balanced twisted pair cable terminations shall comply with, and be tested to TIA/EIA568-B standards for Category 6A requirements in ANSI/TIA-568-C.2, CENELEC EN-50173 series, and ISO 11801:2002 including amendments 1 and 2 installations

1.4 SUBMITTALS

A. Provide product data for the following:

1. Manufacturer's data/cut sheets, product drawing/specifications and installation instructions for all products (submit with bid).

1.5 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the owner or owner representative.
- B. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the owner or the owner representative.
- C. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- D. Material and work specified herein shall comply with the applicable requirements of:
 - 1. ANSI/TIA/EIA – 568-B Commercial Building Telecommunications Cabling Standard, 2015
 - 2. TIA – 569-B Commercial Building Standard for Telecommunications Pathways and Spaces, 2015
 - 3. ANSI/TIA/EIA – 606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2012
 - 4. ANSI-J-STD – 607-B Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2015
 - 5. NFPA 70 – National Electric Code, latest edition
 - 6. BICSI – Telecommunications Distribution Methods Manual, latest edition
 - 7. NEMA – VE-1 – Metal Cable Tray Systems, 2002
 - 8. NEMA – VE-2 – Metal Cable Tray Installation Guidelines, 2001

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING AND COMPONENTS

- A. All voice and data communication cabling shall be a CAT6 solution and shall meet or exceed Category 6 / Class E requirements in ANSI/TIA-568-C.2.

2.2 CABLE AND CONNECTIVITY

- A. Category 6 Cabling
 - 1. Category 6/Class E cable with FEP Plenum (CMP) insulation.
 - 2. Bare copper wire insulated with FEP. Two primaries twisted together to form a pair with four pairs cabled together with a central filler.

3. All four pairs shall be surrounded an aluminum/polyester tape and jacketed with flame-retardant polymer alloy.
 4. Manufacturer: Panduit, no approved equal.
 5. All copper cabling shall be shall be plenum (CMP) rated. All cabling shall bear plenum markings.
 6. Color for voice/data, Blue
 7. Utilize OSP certified cabling where required.
 8. Data cables to be terminated on ports 1 and 2 of the faceplate
 9. Workstation outlets shall be CAT6 Information Outlets with compatible faceplates, surface-mount boxes, and/or modular panels.
 10. Copper patch panels shall be CAT6 Panels.
 11. Contractor shall provide all cable assemblies (patch cords) and cross-connects as required for a complete system.
- B. Modular Patch Panel
1. Mini-Com 48 port 2U, High Density. Populate with Category 6 jacks below
 2. Manufacturer: Panduit, Part/Model No. CPPL48WBLY
- C. Patch Panel Strain Relief Bar
1. Strain relief bar (SRB) are used to support and manage cables in TEC/TDR rooms.
 2. Manufacturer: Panduit, Part/Model No. SRBM19BLY
- D. CAT6 Modular Connector
1. Category 6, RJ45, 10 Gb/s, 8-position, 8-wire universal module.
 2. Mini-Com Punchdown Module (BLUE).
 3. Manufacturer: Panduit, Part/Model No. CJ688TGBL
- E. CAT6 Patch Cords
1. Patch Cords shall be Category 6/Class E, UTP constructed of 28 AWG stranded copper cable with an enhanced performance modular plug on each end.
 2. Copper conductors in patch cable shall be twisted in pairs and separated by a quadrant separator.
 3. Manufacturer: Panduit, Part/Model No. Panduit UTP28P^** (^ = length, ** = color)
- F. Faceplates
1. Mini-Com FlushMount Faceplate
 - a. Flush mount faceplate single gang white
 - b. Manufacturer: Panduit, Part/Model No. CFPL2WHY (2 Port)
 2. Surface Mount Box
 - a. Surface Mount Box shall be two port white
 - b. Manufacturer: Panduit CBX2WH-AY
- G. Hook and Loop Cable Ties

1. Tak-Tape
 - a. The hook and loop cable tie shall be .75" wide with 35 ft. continuous roll.
 - b. The hook and loop cable tie shall be color black.
 - c. Manufacturer: Panduit, Part/Model No. TTS-35RX0
2. Plenum rated hook and loop cable ties for air return spaces – 6"
 - a. The hook and loop cable tie shall be perforated at 6" length.
 - b. The hook and loop cable tie shall be Maroon color.
 - c. Manufacturer: Panduit, Part/Model No. HLSP1.5S-X12
3. Plenum rated hook and loop cable ties for air return spaces – 12"
 - a. The hook and loop cable tie shall be perforated 12" length.
 - b. The hook and loop cable tie shall be Maroon color.
 - c. Manufacturer: Panduit, Part/Model No. HLSP3S-X12
4. Cable Ties for Plenum
 - a. The cable ties shall be Pan-Ty ®, standard cross section.
 - b. 12" long (295cm) length
 - c. The cable tie shall be distinctive Maroon color.
 - d. UL Listed for use in plenum or air handling spaces per NEC.
 - e. Manufacturer: Panduit, Part/Model No. PLT3S-C702Y

H. Horizontal Cable Labels

1. The cable labels shall be self-laminating with 2" x 0.5" printable area.
2. The cable labels shall be compatible with 0.16-0.32" O.D. cables.
3. The cable labels shall be white color.
4. Manufacturer: Panduit, Part/Model No. PLL-40-Y3-1
5. See section 27 05 53 for further labeling requirements.

PART 3 - EXECUTION

3.1 CONTRACTOR

- A. The contractor selected to provide the installation of this system shall be certified by the manufacturing company in all aspects of design, installation and testing of the products described herein.
- B. The contractor shall utilize the authorized manufacturer components and distribution channels in provisioning this Project.
- C. Contractor shall have a minimum of five (5) years of recent experience on structured cabling systems of similar type and size.
- D. Contractor and design firm shall be in compliance with all federal, state and local statutes regarding qualifications of firms.

- E. The contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
- F. The contractor shall own and maintain the tools and equipment approved by the cabling system manufacturer for successful installation and testing of Category 6A balanced twisted pair distribution systems.
- G. The contractor shall have personnel who are adequately trained in the usage of such tools and equipment.
- H. Contractor shall submit a resume of qualification with the Contractor's proposal indicating the following:
 - 1. A list of recently completed projects of similar type and size with contact names and telephone numbers for each
 - 2. A list of test equipment proposed for use in verifying the installed integrity of metallic and fiber optic cable systems on this project.

3.2 CABLE

- A. General (applicable to all cable types) cable shall be installed in strict compliance with the manufacturer's recommendations.
- B. Maintain separation from other conductors (power, fire alarm, etc.) per NEC requirements and TIA/EIA standards.
- C. The bending radius and pull strength requirements of all cable as detailed in the TIA/EIA standards and the manufacturer's installation recommendations shall be strictly observed during handling and installation.
 - 1. Pull cables simultaneously where more than one cable is being installed in the same raceway.
 - 2. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation (Polywater, or approved equal).
 - 3. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cable or raceway.
- D. Cable jackets shall not be twisted during installation. Cables showing evidence of twisting shall be replaced at no additional cost to the Owner, regardless of the outcome of cable testing.
- E. Cable shall be installed in a continuous (non-spliced) manner unless otherwise indicated.
- F. Cable installed in conduit, basket tray, and/or ducts:
 - 1. Fill ratios shall not exceed NEC requirements.
 - 2. Cable shall not be pulled into conduit/ducts until the conduit/duct ends have been prepared for cable installation (i.e. reamed to eliminate sharp edges and insulated throat bushings installed). Cables pulled into conduit/ducts prior to conduit/duct end preparation shall be replaced at no additional cost to the Owner.

3. Reinstate pull-wires in conduits and ducts after use to facilitate future addition of cables.
4. Standard in-wall communication outlets (TSO) shall be installed in a 5"W x 5"L x 2-7/8" deep double-gang backbox with single gang ring with 1-1/4" conduit stubbed to accessible ceiling.

G. Cable installed in cable tray:

1. Cable shall not be attached to the cable tray (i.e. cable shall be left "loose") with the exception of cable installed in cable tray (cable runway) within TEC/TDR Rooms (see "Cable installed in Telecommunications Rooms" below).
2. For performance reasons, station cable in tray shall not be combed.
3. Cable shall be laid in tray in such a way as to present a neat and professional appearance

H. Cable NOT installed in conduit/ducts or cable tray:

1. Cables shall be strapped or fastened for support. Staples and plastic cable ties are not acceptable.
 - a. Straps and fasteners shall not be over-tightened. Cables showing evidence of over-tightening shall be replaced at no additional cost to the Owner, regardless of the outcome of cable testing.
 - b. Straps, fasteners, and tie-wraps installed in plenum spaces shall be plenum rated.
 - c. Reusable Velcro hook and loop style cable straps/fasteners shall be used within Telecom Rooms. The use of plastic tie wraps is not acceptable within Telecom Rooms (see "Cable in Telecom Rooms" below).
 - d. Cables shall be bundled by application (horizontal or backbone) and by cable type (Cat 3, Cat 6 UTP, MM Fiber, SM Fiber, etc.). Cable applications and types shall not be intermixed within a bundle.
2. Cables in suspended cable runs shall be supported at varying intervals. Cable spans shall be limited to 5 feet or less, and the length of spans shall vary along the cable path (i.e. a given span should not be exactly the same length as the span preceding or following it – "exact" spans can degrade cable performance).
3. Cable installed on exposed surfaces or structural members shall be installed parallel and perpendicular to the surfaces. Surface contours shall be followed wherever possible. Cables shall be attached to surfaces at intervals not to exceed 3 feet.
4. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc. – with the exception of ceiling support anchors) is not acceptable.

I. Cable installed in Telecommunications (TEC/TDR) Rooms

1. Cable on backboards:
 - a. Lay and dress all cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings.
 - b. Cable shall be routed as close as possible to the ceiling, floor, sides, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.

- c. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Secure all similarly routed and similar cables together and attach to D-rings vertically and/or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards, or other cables.
- J. Cable terminating on patch panels located on racks.
 - 1. Route cables in Telecom Rooms to patch panels on racks by routing across cable runway to top of rack and then down vertical cable management sections to patch panel.
- K. Cable Slack:
 - 1. Provide cable slack (service loops) at cable ends (both ends) to accommodate future cabling system changes.
 - 2. Provide slack length as follows:
 - a. Provide 10 feet slack loop at the work space end of the cable route. Place slack within accessible space above the ceiling and within 18 inches of the transition into the outlet pathway conduit.
 - b. In the Telecom Room: Route cable around ladder rack to provide a 10' slack loop.

3.3 WARRANTY

- A. Contractor shall certify and provide a system that offers a Manufacturer's Warranty no less than 25 years and Applications Assurance as a registered channel solution.
- B. To offer the manufacturer warranty, the installing contractor must be certified and trained by the manufacture's system for not less than 5 years
- C. Current manufacturer certification shall be valid at the time of installation.

END OF SECTION

SECTION 27 20 00 – DATA COMMUNICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General Description: This specification section covers the installation and configuration of network equipment as specified herein.

1.2 QUALIFICATIONS

- A. General
 - 1. The approved Contractor shall be responsible for satisfactory operation of the system and its certification.
 - 2. Approval of the Owner is required of products or services of the proposed manufacturer, suppliers and installers and will be based upon conformance to the specifications.
- B. Contractor Qualifications
 - 1. Hold current legally required California State Contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated.
 - 2. Must provide letter documenting current status as Cisco certified dealer and installer. Project submittals must include copies of Cisco technician certificates for all individuals that are working on Owner systems.
 - 3. Technicians shall, at minimum, hold Cisco Certified Technician (CCT) Routing and Switching certification.
 - 4. Indicate complete and total compliance with the provisions of these Specifications by letter or by submittal of the bid response forms, signed by an officer of the corporation, or a principal if other ownership exists. In addition, the letter or forms shall include a complete listing of exceptions, if any.

1.3 GENERAL CONDITIONS

- A. Contract Compliance: Provide the Systems and Services in accordance with the conditions and system descriptions as described in Part 1 of each specification section. Provide specified products as described in Part 2 of each specification section. Utilize specified procedures and practices as described in Part 3 of each specification section.
- B. Codes: Furnish material and workmanship for this work in conformance with applicable legal and code requirements.

1.4 RELATED WORK

- A. In accordance with Section 28 23 00, Video Surveillance System

1.5 PRECEDENCE

- A. Obtain, read and comply with General Conditions and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable sub-section and directions as contained herein, this section shall govern.

1.6 SHOP DRAWINGS & EQUIPMENT SUBMITTAL

- A. General: Bid documents and specifications are considered conceptual in nature and provide direction on products and project requirements. Contractor is given a choice of methods that may be incorporated into the system. These choices may affect the overall design, configuration, and installation of the proposed system.
- B. Contractor Responsibility: Prepare and submit shop drawings, which show details of all work to ensure proper installation of the work using those materials and equipment specified or allowed under the approved plans and specifications. A complete Shop Drawing submittal package shall consist of Drawings, Equipment Data Sheet Submittals, and an Acceptance Testing Plan.
- C. Completeness: The Equipment Submittals, Acceptance Testing Plan and the Shop Drawings should be submitted as a complete and contiguous package. Partial or unmarked submittals will not be accepted for review.
- D. Scheduling: A schedule of shop drawing submissions shall be submitted for the Owner's review on a form acceptable to the Owner within ten (10) days after award of the Contract. The schedule of shop drawing submissions shall include as a minimum, but not limited to the requirements stated herein.
- E. Requirements: Provide the following information complete, and in the manner described herein:
 - 1. Hardware, Application Software, and Network Requirements: A system description that shall show how the equipment will operate as a system to meet the performance requirements of the systems. The following information shall be supplied as a minimum:
 - a. Server(s) processor(s), disk space and memory size and/or expansion of existing
 - b. Operating System(s) Software, where software is provided or upgraded
 - c. Application Software
 - d. Network bandwidth and reliability requirements
 - e. Number and locations of equipment
 - f. Other specific network requirements, preferences, and constraints
 - g. Backup/archive system size and configuration

- h. Start-up operations
 - i. System power requirements
 - j. Device/component environmental requirements (cooling and or heating parameters)
2. Shop Drawings: Shop Drawings shall be numbered consecutively and shall accurately and distinctly present the following information:
- a. Title Sheet:
 - b. Single-Line/Block Diagrams: Show signal relationships of equipment and devices within the system.
 - c. Component Connection Diagrams:
 - 1) For each equipment component show the rear elevation of the device and all connectors/terminations as a pictorial.
 - 2) Show the wire designations on connectors. Typical wiring detail where multiple of same device is provided.
 - d. Equipment Wiring Diagrams:
 - 1) Show a pictorial illustration of each piece of equipment.
 - 2) Show the device nomenclature exactly as shown on the single line diagrams.
 - 3) Connections
 - a) Every connection in the system must be documented.
 - b) Connection information may be rendered as a list(s), if properly coordinated with, and referenced to, typical component and single-line diagrams. Otherwise, the Shop Drawings shall show a pictorial of every component in the system, with its connections.
 - e. Necessary details, including complete information for making connections between work under this Contract, existing work, and work under other Contracts.
 - f. Each Drawing or page shall include:
 - 1) Project name, Project Number, and descriptions.
 - 2) Submittal date and space for revision dates.
 - 3) Identification of equipment, product, or material.
 - 4) Name of Contractor and Subcontractor.
 - 5) Name of Supplier and Manufacturer.
 - 6) Physical dimensions clearly identified.
 - 7) ASTM and Specifications references.
 - 8) Identification of deviations from the Contract Documents.
 - 9) Contractor's stamp, initialed or signed, dated and certifying to review of submittal, and compliance with Contract.
 - 10) Location at which the equipment or materials are to be installed.
3. Equipment Submittals
- a. Provide a Title Page, with project name, Contractor's name and address, contact information, date of submission, and submission revision number.

- b. Provide a Parts List, for proposed equipment, materials, components and devices, listing the following information for each line item:
 - 1) Model number
 - 2) Specification sheet page reference
 - c. Provide Manufacturers Specification Sheet with descriptive information for equipment, materials, components, and devices. Number each page, to correspond with the Parts List.
 - d. Clearly delineate (with highlighter, arrow, or underline) on each specification sheet, specific model numbers, options and configurations being proposed for this project.
 - e. Indicate kinds of materials and finishes for equipment where more than one option is presented.
 - 4. Acceptance Testing Plan
 - a. Submit a written document detailing the test procedures to be followed in evaluating and proving the installed system(s).
 - b. Provide a sample of the test forms to be used for each system and for each component of each system.
 - c. Include all tests required by the equipment manufacturer and by this Specification.
- F. The Owner will return unchecked any submittal which does not contain complete data on the work and full information on related matters.
- G. Verification: The contractor shall check and acknowledge all shop drawings and shall place his signature on all shop drawings submitted to the Owner. Contractor's signature shall constitute a representation that all quantities, dimensions, field construction criteria, materials, catalog numbers, performance criteria and similar data have been verified and that, in his opinion, the submittal fully meets the requirements of the Contract Documents.
- H. Timeliness: The Contractor shall schedule, prepare, and submit a complete shop drawing assembly in accordance with a timetable that will allow his suppliers and manufacturers sufficient time to fabricate, manufacture, inspect test and deliver their respective products to the project site in a timely manner so as to not delay the complete performance of the work.
- I. Departure from Contract Requirements: If shop drawings show departures from the Contract requirements, the Contractor shall make specific mention thereof in his letter of transmittal, otherwise review of such submittals shall not constitute review of the departure. Review of the drawings shall constitute review of the specific subject matter for which the drawings were submitted and not of any other structure, materials, equipment, or apparatus shown on the drawings.
- J. Contractor Responsibility: The review of shop drawings will be general and shall not relieve the Contractor of responsibility for the accuracy of such drawings, nor for the proper fitting and construction of the work, nor for the furnishing of materials or work

required by the Contract. No construction called for by shop drawings shall be initiated until such drawings have been reviewed and approved.

- K. Shop Drawing Submittal Review: The procedure in seeking review of the shop drawings shall be as follows:
1. The Contractor shall submit one (1) complete electronic set of shop drawings with equipment submittals and other descriptive data with one copy of a letter of transmittal to the Owner for review thirty (30) working days after award of the contract. The letter of transmittal shall contain the project name, the Owner's Project Number, the name of the Contractor, the list of drawings submitted including numbers and titles, requests for any review of departures from the contract requirements and any other pertinent information. Drawings submitted for review shall be PDF format drawings and included with the equipment submittals.
 2. Drawings or descriptive data will be stamped "Reviewed", "Furnish as Corrected", "Revise and Resubmit", "Rejected" or 'Submit Specific Item' and one copy with a Letter of Transmittal will be transmitted to the Contractor with the return of submitted documents.
 3. If a shop drawing or data is stamped "Reviewed" or "Furnish as Corrected", no additional submittal is required for that shop drawing.
 4. If a shop drawing or data is stamped "Revise and Resubmit" or "Rejected", the Contractor shall make the necessary corrections and resubmit the documents as required above. The letter transmitting corrected documents shall indicate that the documents are re- submittals.
 5. If any corrections, other than those noted by the Owner, are made on a shop drawing prior to resubmittal, such changes should be pointed out by the Contractor upon resubmittal.
 6. The Contractor shall revise and resubmit the shop drawing as required, until they are stamped either "Reviewed" or "Furnish as Corrected."
 7. After the Contractor's submittal or resubmittal of shop drawings, the Owner shall be provided with fifteen (15) working days for review. Should the Owner require additional review time above and beyond the stated fifteen (15) working days, the Contractor may ask for a time extension and/or monetary compensation, if they can present valid, factual evidence that actual damages were incurred by the Contractor. The Owner shall determine the amount of the time extension and/or the monetary compensation to be awarded the Contractor.
 8. The Owner will not issue a "Notice to Proceed" until shop drawings are reviewed, unless otherwise approved by the Owner.
 9. The Contractor shall be responsible for extra costs incurred by the Owner caused by the Contractor's failure to comply with the procedure outline above.

1.7 OPERATING AND MAINTENANCE MANUALS

- A. Phase One: Notwithstanding requirements specified elsewhere, submit the following labeled as the "Operating and Maintenance Manual" within thirty (30) days after Final Acceptance of the Installation:

1. Record Drawings: Submit one (1) copy of revised versions of drawings as submitted in the "Shop and Field" and "Equipment Wiring Diagrams" Submittals showing actual device locations, connections and relationships as they were installed. Drawings shall include room numbers coinciding with Owner space planning numbering. Drawings shall be submitted in electronic editable format, on USB drive.
2. Manuals: Submit one (1) copy of each of the following materials in bound manuals, or electronic PDF copies on USB Drive:
 - a. A final Bill of Material.
 - b. Equipment Instruction Manuals: Complete, project specific comprehensive instructions for the operation of devices and equipment provided as part of this work.
 - c. Manufacturers Instruction Manuals: Specification sheets, brochures, Operation Manuals, and service sheets published by the manufacturers of the components, devices and equipment provided.
 - d. Include information for testing, repair, troubleshooting, assembly, disassembly, and recommended maintenance intervals.
 - e. Provide a replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.
 - f. Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.
 - g. Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturers' Warranty Registration papers as described herein.
- B. Phase Two: Within fourteen (14) days of receipt of engineer reviewed Operating and Maintenance Manual (Phase One), submit one (1) electronic copy in editable format of the reviewed Record Drawings and one (1) copies of the reviewed Operating and Maintenance Manuals to the Owner, on USB Drive.
 1. The contractor shall provide to the Owner one (1) copy of new executive and user software, including required graphical maps, on USB Drive.
 2. Sufficient information, (detailed schematics of subsystems, assemblies, and subassemblies to component level) clearly presented, shall be included to determine compliance with drawings and specifications.

1.8 WARRANTY

- A. Furnish and guarantee maintenance, repair and inspection service for the system using factory trained authorized representatives of the manufacturer of the equipment for a period of one year after final acceptance of the installation.
- B. Third Party Device warranties are transferred from the manufacturer to the contractor, which may then transfer third party warranties to the Owner. Specific third-party warranty details, terms and conditions, remedies, and procedures, are either expressly stated on, or packaged with, or accompany such products. The warranty period may vary from product to product. These products include but are not limited to devices that are

directly interconnected to the field hardware or computers and are purchased directly from the manufacturer.

- C. Purpose
 - 1. The Contractor shall repair any system malfunction or installation deficiency discovered by the Owner during the burn in and warranty period.
 - 2. The Contractor shall correct any installation deficiencies found against the contract drawings and specifications discovered by the Owner during the warranty period.
- D. The service contract shall cover equipment and software related to this contract, and shall provide for the following parts and services, without additional cost to the Owner:
 - 1. Service Contract shall cover a 1-year agreement within the base scope.
- E. Response Time: Response time for service calls.
 - 1. Emergency service calls where system is not responding to staff directed commands through the computer systems shall be within 8 hours to the project site.
 - 2. Emergency service calls where controllers are not reporting shall be within 4 hours to the project site.
 - 3. Normal service calls for device malfunctions shall be within 48 hours during normal working hours to the site.
- F. Repair Time: Contractor shall stock parts in sufficient quantities such that repair, or replacement shall be guaranteed within 12-hours. Temporary replacements within this time period shall be acceptable, provided temporary replacements do not compromise system functionality, and provided permanent replacement is achieved within 48 hours. Contractor may contact Owner for use of Owner supplied spare parts where delay of system repair will have negative impact on system performance.
- G. Commencement: The warranty begins at the time of issuance of the statement of "Final Acceptance of the Installation" by the Owner.
- H. Transferability: The warranty shall be transferable to any person or persons at the discretion of the Owner.
- I. Transmittal: A copy of this Warranty shall be delivered to and signed for by the Owner. A copy of the signed Warranty document shall be delivered for review as part of the Final Submittals.
- J. Registration: Register Warranty papers for all equipment and software in the name of the Owner. Furnish reproductions of all equipment Warranty papers to the Owner with the Final Submittals.
- K. Sub-Contracting: Warranty service work may not be sub-contracted except with specific permission and approval by the Owner.
- L. Resolution of Conflicts

1. The Owner retains the right to resolve unsatisfactory warranty service performance at any time by declaring the work unsatisfactory, stating specific areas of dissatisfaction in writing.
2. If the Contractor or his approved subcontractor does not resolve such stated areas of dissatisfaction within thirty (30) days, the Owner may appoint any alternative service agency or person to fulfill the terms of the Warranty; the cost of which shall be borne by the contractor. This action may be taken repeatedly until the Owner is satisfied that Warranty service performance is satisfactory. Satisfactory resolution of a malfunction shall be considered adequate when the device, equipment, system, or component which is chronically malfunctioning is brought into compliance with the standards of performance as contained herein and published by the manufacturers of the equipment installed.

1.9 OWNER'S RIGHT TO USE EQUIPMENT

- A. The Owner reserves the right to use equipment, material and services provided as part of this work prior to Acceptance of the Work, without incurring additional charges and without commencement of the Warranty period.

1.10 EXISTING SYSTEMS

- A. Network Communications Equipment - Local Area Network (LAN)
 1. Modifications to the Existing System
 - a. The addition or replacement of existing equipment with new shall provide services and functions identical to the existing system in addition to any new functions and services specified herein.
 - b. The Contractor shall use and expand, as necessary, the existing system as part of this work, including but not limited to servers, software, and software licensing.
 - c. Contractor shall coordinate with the Owner to ensure new and modified systems are fully and seamlessly integrated into the existing system.
- B. Refer to 28 05 00, Security System General Requirements for related work.

1.11 TECHNICAL REQUIREMENTS & SCOPE OF WORK

- A. Network Equipment
 1. The Owner maintains and operates an existing Cisco network. The Contractor shall furnish, install, and program new equipment as specified.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Product Acceptability: The Products section contains lists of acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified. Considerations may include but shall not be limited to functional, physical, aesthetic and/or interface aspects. The Owner shall be the sole judge of whether or not a submitted substitution is deemed to be "equivalent" to that specified.

2.2 NETWORK EQUIPMENT

A. General

1. Refer to Enclosure B for final parts list.

B. Equipment

Part	Manufacturer	Model
Catalyst 9300 48-port Universal Power Over Ethernet (UPOE), Network Advantage	Cisco	C9300-48U-A
SOLN SUPP 8X5XNBD Catalyst 9300 48-port Universal Power Over Ethernet (UPOE), Network Advantage	Cisco	CON-SSSNT-C93004UA
1100W Alternating Current (AC) 80+ platinum Config 1 Power Supply	Cisco	PWR-C1-1100WAC-P
1100W Alternating Current (AC) 80+ platinum Config 1 Secondary Power Supply	Cisco	PWR-C1-1100WAC-P/2
North America Alternating Current (AC) Type A Power Cable	Cisco	CAB-TA-NA
C9300 DNA Advantage , 48-Port, 5 Year Term License	Cisco	C9300-DNA-A-48-5Y
Cisco ONE Add-On Session Opt Out (No Fulfillment)	Cisco	C1-ADD-OPTOUT
Catalyst 9300 2 x 25GE Network Module	Cisco	C9300-NM-2Y
10/25GBASE-LR SFP28 Module	Cisco	SFP-10/25G-LR-S
10GBASE-CU Small Form-factor Pluggable Transceiver Plus (SFP+) Cable 5 Meter	Cisco	SFP-H10GB-CU5M
Catalyst 9500 48-port x 1/10/25G + 4-port 40/100G, Advantage	Cisco	C9500-48Y4C-A
SOLN SUPP 8X5XNBD Catalyst 9500 48-port 25/100G only, Advantage	Cisco	CON-SSSNT-C9504YA4
650W Alternating Current (AC) Config 4 Power Supply front to back cooling	Cisco	C9K-PWR-650WAC-R
650W Alternating Current (AC) Config 4 Power Supply front to back cooling	Cisco	C9K-PWR-650WAC-R/2

Power Cord, 125V Alternating Current (AC) 13 Amp (A) National Electrical Manufacturers Association (NEMA) 5-15 Plug, North America	Cisco	CAB-9K12A-NA
C9500 DNA Advantage , Term License	Cisco	C9500-DNA-48Y4C-A
Catalyst 9500 NW and Cisco DNA Advantage license (5Y)	Cisco	C9500-DNA-A-5Y
10/25GBASE-LR Small Form-factor Pluggable Transceiver (SFP) SFP28 Module	Cisco	SFP-10/25G-LR-S
10GBASE-CU Small Form-factor Pluggable Transceiver Plus (SFP+) Cable 5 Meter	Cisco	SFP-H10GB-CU5M

PART 3 - EXECUTION

3.1 GENERAL

- A. Perform this work in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.
- B. The Contractor shall ensure that installation personnel understand the requirements of this Specification.

3.2 COORDINATION

- A. General
 1. This Contract involves functioning systems. Coordination with the Owner is critical. Do not interrupt any functioning system without coordinating with the client.
 2. Coordinate the work with the Owner and all trades to assure that where this work interfaces to other trades, those interfaces are provided, complete and functional.
 3. Meet with the Owner and each trade. Identify devices needed to complete functional operation of this work which are being provided by Owner, General Contractor or another trade, and assure that the work being provided by others will be acceptable.
 4. Make sure work by others is scheduled in order that this work can be installed in a timely fashion.
 5. Verify work by others which may be necessary to facilitate the work and coordinate with other trades. Assure that related work by others is coordinated with this work.
- B. Required Resources: Become familiar with the available access and space for equipment and any potential interference requiring coordination. Coordinate with the Owner to assure that adequate electrical and HVAC, services are available. Provide the physical space for equipment, and ample access room for installation and maintenance of equipment.
- C. Interface Devices: Provide items necessary to complete this work in conformance with the Contract Documents or the satisfaction of the Owner without any additional expense.

- D. Equipment shall be mounted with sufficient clearance to meet applicable codes and facilitate observation and testing. Securely hang and/or fasten with appropriate fittings to ensure positive grounding, free of ground loops, throughout the entire system. Units shall be installed parallel and square to building lines.
- E. Where new equipment is replacing old equipment, Contractor is responsible for removing the old equipment.
- F. Project Documentation: Review project documentation. If the Contractor perceives conflict or ambiguity in the contract documents, he shall seek interpretation from the Owner. Failure to do so may result in remedial work.
- G. Project Schedule: Immediately obtain and follow the project schedule established by the Owner. Failure to maintain the schedule may result in a requirement by the Owner to expend extra effort until the project schedule has been achieved.
- H. Schedule Changes: Time is of the essence of this agreement. In the event that it becomes necessary for the Contractor to expend "extra effort" to complete the work according to schedule changes not covered above, the Contractor agrees to cooperate with the Owner in good faith to complete the work according to schedule requirements.
- I. Supervision: Maintain a competent supervisor and supporting technical personnel acceptable to the Owner during the entire installation. A change of supervisor during the project shall not be acceptable without prior written approval from the Owner.
- J. Work and Manpower Rules: Comply with applicable jobsite work and manpower regulations.
- K. Found Conflicts: Continuously make known to the Owner, conflicts discovered which may affect the orderly completion or the specified performance of this work. Cooperate with the Owner and other trades to accommodate such changes as may be necessary to resolve found conflicts.
- L. Coordination Difficulties: Promptly notify the Owner in writing of any difficulties which may prevent proper coordination or timely completion of this work. Failure to do so shall constitute acceptance of construction as suitable, to receive this work, except for defects that may develop in the work of others after its execution.
- M. Environmental: Verify the intended location(s) for equipment is suitable for the equipment. If conditions such as temperature, humidity, dust level or the like require modification, make it known to the Owner immediately upon award of the contract. If equipment requires strict environmental conditions (dust limitations, etc.), notify the Owner immediately upon award of the Contract. Failure to notify the Owner of such conditions shall constitute acceptance of the conditions and any later required modifications to the equipment or the environment shall be at the sole cost of the Contractor.

- N. Extra Effort: The Owner retains the right to require the Contractor to expend whatever extra effort as may be required, in event the Contractor fails to perform satisfactorily at any milestone date, unless such delay is approved in writing by the Owner, or it can be proved by the Contractor that such delay was caused by other contractors, or Owner's intransigence relating to Owner requested changes in the scope of work. Any costs pursuant to such extra effort will be borne solely by the Contractor. If Project Schedule delays are approved, provide the Owner with monthly revisions of the Project Schedule reflecting actual performance vs. the schedule.

3.3 WORKMANSHIP

- A. The installation shall be performed in a professional and workmanlike manner.
- B. On a daily basis, clean up and deposit in appropriate containers debris from work performed under the appropriate Specification sections. Owner and organize parts, tools and equipment when not being used.
- C. Preparation, handling, and installation shall be in accordance with the Manufacturer's written instructions and technical data appropriate to the product specified.
- D. Work shall conform to the National Electrical Contractor's Association "Standard of Installation" for general installation practice.
- E. At the conclusion of the installation, work areas, including panel boxes, shall be vacuumed and cleaned to remove debris and grease.

3.4 SOFTWARE CONFIGURATION

- A. Contractor shall coordinate with the Owner to determine the required configuration requirements for network equipment.

3.5 START-UP RESPONSIBILITY

- A. Contractor shall initiate System Operation. Competent start-up personnel shall be provided by Contractor on each consecutive working day until the System is functional and ready to start the acceptance test phase. If in Owner's judgment Contractor is not demonstrating progress in solving any technical problems, Contractor shall supply Manufacturer's factory technical representation and diagnostic equipment at no cost to Owner, until resolution of those defined problems. Where appropriate, Contractor will bring the System on-line in its basic state (i.e., alarm reporting, facility code access control, etc.).
- B. Properly ground each piece of electronic equipment prior to applying power.
- C. Properly ground all shielded wire shields to the appropriate earth ground at the hub end only, not at the remote or device end.

- D. Use a start-up sequence that incrementally brings each portion of the system on-line in a logical order that incorporates checking individual elements before proceeding to subsequent elements until the entire system is operational.

END OF SECTION 27 20 00

SECTION 28 05 00 – SECURITY SYSTEMS GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Standard Guidelines referenced in Division 01 Summary Section, apply to this Section.

1.2 BASIC DEFINITIONS

- A. Los Angeles County (LAC) shall be hereinafter referred to in this document as Owner and the respondent shall be referred to as Contractor. The term Owner includes direct employees and other appointed Owner agents such as Architects or consultants. These agents may be requested by Owner to represent Owner in undertaking certain project tasks.
- B. “Days”: As used in the specifications, the word “days” means calendar days including weekend days.
- C. Provide”: As used in the plans and specifications, the word “provide” means to furnish, install, connect, program, test, commission and warranty the subject material or services.
- D. Specified Items – Substitutions
 - 1. “No Acceptable Equal”: The exact make and model number identified in this Specification shall be provided without exception. Where compatibility with existing systems is specified, and where a specific make or model number is not identified, the Contractor shall provide equipment which is compatible with, and equivalent to, existing equipment of the same description and type, and serving the same purpose.
 - 2. “Or Equal”: An item may be substituted for the specified item provided that in every technical and aesthetic sense, the substituted item provides the same or better capability than the specified item, and is fully compatible with the new or existing systems specified. For expansion of existing systems, the item shall also be approved and fully supported by the existing system manufacturer. The Owner shall be the sole authority to determine the equality of substituted products with specified items.
 - 3. “Aesthetics”, or “Aesthetic Considerations”: If aesthetic considerations are involved in either the ‘or equal’ or ‘approved equal’ category, this shall be a consideration in approving or disapproving the proposed substitute. If the proposed substitute is aesthetically unacceptable to the Owner, then the specified, or another technically equal item, shall be provided.
- E. “Beneficial Use”: Each component of a system is not considered available for beneficial use until and unless all components and conditions have been fulfilled to make the system fully operational.

1.3 SITE ACCESS CONTROL

- A. The Contractor shall obtain rules and regulations from the Owner's Project Manager and shall train construction and delivery personnel on their requirements. Contractor shall consistently remain in contact with the Owner for revisions to project policy, and shall be held fully responsible for monitoring and ensuring Contractor and Subcontractor compliance to Owner Access Control rules and regulations as directed by the Owner.
- B. Contractor's personnel, operating forces, and delivery personnel shall strictly follow all rules and regulations concerning Access Control at the site, including but not limited to those relating to credentialing, background checks, and access to restricted and secure areas, parking, the handling of Access Control information, and the use of the facility.

1.4 DESCRIPTION

- A. General Description: This specification section covers general requirements for the furnishing, installation and testing of a complete expansion to the Owner' video surveillance system.
- B. Furnish and install Video Surveillance System (VSS) software programming, hardware devices, mounting brackets, power supplies, video servers, Network Video Recorders (NVR), and equipment enclosures, as shown and specified.
- C. Furnish and install outlets, junction boxes, pull boxes, conduit, backboxes, special/custom backboxes, connectors, wiring, and other accessories necessary to complete the system installation. Requirements shall be in accordance with Division 26, Electrical Work.

1.5 SCOPE OF WORK

- A. Systems: Provide a Video Surveillance System (VSS) per the contract schedule, and with acceptable engineering and installation practices as described herein.
- B. Areas of work include, but are not limited to:
 - 1. Shop Engineering and Documentation
 - 2. Wiring and Installation Diagrams
 - 3. Submittals
 - 4. Coordination
 - 5. System Installation
 - 6. Training
 - 7. Start-up Testing
 - 8. Commissioning
 - 9. Close out & As-Build documentation
 - 10. Warranty

1.6 BID RESPONSE

A. Bidders Responsibility

1. Contractor is responsible for verifying actual conditions by visiting the site, reviewing the Specifications and drawings, and to advise the Owner in writing of any conditions which may adversely affect the work. If any necessary exceptions are discovered, Contractor shall immediately notify the Owner for resolution prior to any change in the design or the scope, and any resultant claim for additional compensation.
2. The Bid Response must fulfill the intent of the Drawings and Specifications to the satisfaction of the Owner to qualify as an acceptable Bid Response.

B. Substitutions

1. Catalog and/or model numbers for Owner approved equipment and systems are included as a part of these specifications.
2. Any substitution proposed by Contractor for catalog numbers and brands or trade names noted or specified herein shall be solely at the Contractors risk. The Owner maintains sole authority to hold a review of substitutions, and sole authority to approve or disapprove of substitutions for any reason.
3. The Owner's acceptance of substitutions shall not relieve Contractor from complying with the requirements of the drawings and Specifications. Contractor shall be responsible, at Contractor's sole expense, for any changes resulting from Contractor's substitutions that affect other parts of Contractor's own work or the work of others.

C. Technical Bid Submission: At bid submission, submit one (1) copy of the following

1. An equipment list with names of Manufacturers of primary systems (VSS) including model numbers and technical information on equipment proposed.
2. A letter from the manufacturer(s) stating that the system Contractor is an authorized distributor or installer of the proposed primary systems (VSS).
3. Indicate complete and total compliance with the provisions of these Specifications by letter or by submittal of the bid response forms, signed by an officer of the corporation, or a principal if other ownership currently exists. If there are exceptions to the specifications, submit a statement listing every technical and operational parameter wherein the submitted equipment or system may vary from that which was originally specified. If the submitter fails to list a particular variance and his submittal is accepted, but is subsequently deemed to be unsatisfactory because of the unlisted variance, the submitter must replace or modify such equipment at once and without cost to the Owner.
4. Failure of Contractor to submit the above information shall be considered non-responsive to the bid requirements and sufficient cause for bid rejection.

D. Examination of Site and Verification of Existing Conditions

1. Contractor shall have visited the site and familiarized himself with existing conditions prior to submitting his bid and shall be prepared to carry out the work within the existing limitations. Failure or neglect to do so shall not relieve Contractor

of his responsibilities nor entitle him to additional compensation for work overlooked and not included in his bid.

2. Existing structures and utilities shown on the contract drawings are obtained from project drawings and exploratory field examination. Contractor shall verify existing conditions and required dimensions, including those shown on the drawings, by measurement at the job site. Contractor shall notify the Owner of exceptions before proceeding with the work.
3. Contractor shall confirm the availability of the proper power source for each piece of specified equipment, through site visits and drawings as necessary. Where proper power does not exist, Contractor shall identify this situation to the Owner for guidance. Should the Owner direct Contractor to provide the necessary power, it shall be provided using equipment and methods authorized by the Owner.

- E. Data Accuracy: Absolute accuracy of information regarding existing conditions cannot be guaranteed. The Drawings and Specifications are for the assistance and guidance of Contractor and exact locations, distances, and elevations will be governed by actual field conditions. Where variations from the bid documents are required, such variations shall be approved by the Owner.

1.7 QUALIFICATIONS

A. General

1. The approved Contractor shall be responsible for satisfactory operation of the system and its certification.
2. Approval of the Owner is required of products or services of the proposed manufacturer, suppliers and installers and will be based upon conformance to the specifications.

B. Manufacturer Qualifications

1. System components shall be furnished by manufacturers of established reputation and experience who shall have produced similar equipment and who shall be able to refer to similar installations rendering satisfactory service.
2. The manufacturer's products shall have been in satisfactory operation on at least three similar installations for not less than three years. Contractor shall submit a list of similar installations.
3. Components including, but not limited to, cameras, computers, and power supplies shall have been tested and listed by Underwriters Laboratories, Inc., Factory Mutual Systems, or other approved independent testing laboratory.
4. Components installed within a common enclosure shall be approved by an agency recognized by the local city Department of Building and Safety as an assembly.

C. Contractor Qualifications

1. Hold current legally required California State Contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Contractor shall submit copies of licenses to Owner prior to the start of work.

2. Hold current legally required state registrations required to meet local requirements for submittal drawings
3. Have manufacturers trained and certified engineering, field technicians and programming staff.
4. Indicate complete and total compliance with the provisions of these Specifications by letter or by submittal of the bid response forms, signed by an officer of the corporation, or a principal if other ownership exists. In addition, the letter or forms shall include a complete listing of exceptions, if any.

1.8 PHASING PLAN

- A. The work shall be performed in phases.
 1. Each phase of work shall include, but not be limited to the provision of applicable conduit, power, equipment, programming, and documentation to provide a complete, operational system, as described herein.
 2. Coordinate work phasing with the Owner
 3. Within 14 days after award of the project, submit a preliminary phasing plan to the Owner for review. The Shop Drawings shall reflect the process of the phasing plan.
- B. The Phasing Plan shall be designed to allow the continuation of Owner business and activities and to limit down- time of critical systems, during construction. Each system element shall be addressed individually. Phases and system elements may be combined, or rearranged, based upon planned work schedules and available labor to perform the work.
- C. Phasing Plan: The proposed phasing plan should address the upgrades with the following approach:
 1. Install or coordinate with the Owner on the installation of the required network connectivity.
 2. Install, power, and test the control equipment, including but not limited to video recorders, computer workstations, and application software. Where new equipment will replace existing equipment in the same location, provide temporary installation of the new equipment.
 3. Install conduit, cable, and new devices. Connect to controls, and test.
 4. Install conduit, cable, and devices which replace existing devices. Connect to controls, and test.
 5. Where new equipment replaces existing equipment in the same location, remove existing and install the new equipment. Reconnect pre-tested devices, and test again.
 6. Program, configure, test and commission the system as required by the Owner and these specifications.
- D. Modifications to the Phasing plan may be submitted by the Contractor, after the Shop Drawings and Equipment Submittals have been reviewed and accepted for installation. The Contractors' modified phasing plan shall be based upon Contractor's actual proposed equipment, project schedule and installation planning. The proposed phasing plan shall be designed to achieve the same goals as the phasing plan contained herein.

The Contractors' plan must be accepted by the Owner prior to any demolition or installation of equipment and cable. The Owner reserves the right to modify the proposed plan, or any part thereof.

1.9 GENERAL CONDITIONS

- A. Contract Compliance: Provide the Systems and Services in accordance with the conditions and system descriptions as described in Part 1 of each specification section. Provide specified or Owner approved equivalent alternate products as described in Part 2 of each specification section. Utilize specified procedures and practices as described in Part 3 of each specification section.
- B. Codes: Furnish material and workmanship for this work in conformance with applicable legal and code requirements.
- C. Inclusive Work: Provide sufficient time, material, and manpower to verify, revise or refine the Bid Drawings as necessary to develop fully engineered Shop Drawings as required by the General Requirements, and in order for this work to realize complete, stable and safe operation.

1.10 RELATED WORK

- A. General
 - 1. Observe interface procedures to related work.
 - 2. Coordinate with the Owner on aspects of aesthetic interface.
 - 3. Coordination: Coordinate this work with related work by other contractors.
 - 4. Coordinate with existing construction, equipment, and field devices.
 - 5. Equipment provided under this project shall be installed in a manner consistent with architectural, operational, service and maintenance considerations.
 - 6. "Coordinate" related work not specifically mentioned below.
- B. Owner's General Provisions and Work Contract
- C. Division 01, General Requirements: Coordinate this work with applicable sections of the Owner's General Requirements and General Provisions.
- D. Finishes: Coordinate this work with applicable Owner requirements for Finishes, including but not limited to the following.
 - 1. Painting/Patching: Provide painting, patching and repair services to match existing conditions.
 - 2. Painting of walls shall be from corner of nearest wall across repair area to nearest wall on opposite side of repair area.
- E. Division 26, Electrical
 - 1. Coordinate this work with applicable sections of Division 26, Electrical, including but not limited to the following:

- a. Electrical power distribution sources for existing buildings shall be by the Owner unless otherwise noted. Contractor shall coordinate with the Owner to identify and verify 120-volt power service requirements with the first shop drawing submittal.
 - b. Conduit, boxes, and rough-in material shall be provided and installed by the Contractor, unless otherwise noted.
 - c. Specialty boxes shall be provided by the Contractor and installed by the Contractor, unless otherwise noted.
- F. Division 27, Communications
 - 1. General: Coordinate this work with applicable sections of Division 27, Communications, including but not limited to structured cabling, fiber optic cabling, telephone, and data communications requirements.
 - 2. Contractor shall coordinate with the Owner to identify and verify shared cable/pathway, LAN ports, and bandwidth requirements at the time of the first shop drawing submittal.
- G. Division 28, Electronic Safety and Security
 - 1. Section 28 05 00 – Security System General Requirements
 - a. Provide equipment and services required by related Sections pursuant to the requirements of Section 28 05 00, Security System General Requirements.
 - 2. Section 28 05 53 – Identification for Electronic Safety and Security
 - a. Provide equipment and services required by related Sections pursuant to the requirements of Section 28 05 53, Identification for Electronic Safety, and Security.
 - 3. Section 28 08 00 – Testing and Commissioning
 - a. Provide equipment and services required by related Sections pursuant to the requirements of Section 28 08 00, Testing and Commissioning.
 - 4. Section 28 23 00 - Video Surveillance System
 - a. Provide equipment and services required by Section 28 23 00, Video Surveillance System, pursuant to the requirements of this section.

1.11 PRECEDENCE

- A. If any statement in this or any other security specification is in conflict with any provision of the General Terms and Conditions of the contract, the provision stated in the General Terms and Conditions shall take precedence. Any questions that result from such potential conflict, which require additional interpretation and guidance shall be immediately brought to the Owner's attention.
- B. Obtain, read and comply with Division 26, Electrical and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable Division 26 sub-sections and directions as contained herein, this section shall govern.
- C. Architectural drawings shall have precedence over other drawings in regard to dimensions and location.

1.12 APPLICABLE PUBLICATIONS

- A. The edition of the appropriate code or standard at the time of permitting shall govern all applications.
- B. Standards: Perform the work in accordance with the following standards:
 - 1. UL Underwriters Laboratories, Inc., UL 294, UL 1076, ULC
 - 2. EIA Electrical Industries Association.
 - 3. NTSC National Television Standards Committee.
 - 4. NEMA National Electrical Manufacturers Association.
 - 5. NECA National Electrical Contractor's Association, Standards of Installation.
 - 6. NFPA National Fire Protection Association 101 Life Safety Code
 - 7. CCR Title 24 California Building Code
 - 8. CCR Title 24 California Electric Code
 - 9. ADA Americans With Disabilities Act
 - 10. FCC Part 15, Part 68
 - 11. IEEE RS 170 variable standard NTSC (color camera broadcast)
- C. Where more than one code or regulation is applicable, the more stringent shall apply.
- D. Cable installation, identification and termination shall be performed in accordance with manufacturer's installation manuals in addition to the above applicable codes.
- E. In the absence of manufacturer's recommendations on conductor applications, the Contractor shall ensure that the cable selected meets all technical requirements of the location of its installation, and of the equipment to be installed.

1.13 SHOP DRAWING & EQUIPMENT SUBMITTAL

- A. General: Bid documents, including drawings, details and specifications are considered conceptual in nature, and provide direction on products and project requirements. Contractor is given a choice of methods that may be incorporated into the system. These choices may affect the overall design, configuration, and installation of the proposed system.
- B. Contractor Responsibility: Prepare and submit shop drawings, rendered in the latest AutoCad format, which show details of all work to insure proper installation of the work using those materials and equipment specified or allowed under the approved plans and specifications. A complete Shop Drawing submittal package shall consist of Drawings, Equipment Data Sheet Submittals, and an Acceptance Testing Plan.
- C. Completeness: The Equipment Submittals, Acceptance Testing Plan and the Shop Drawings should be submitted as a complete and contiguous package. Partial or unmarked submittals will not be accepted for review.

- D. Scheduling: A schedule of shop drawing submissions shall be submitted for the Owner's review on a form acceptable to the Owner within ten (10) days after award of the Contract. The schedule of shop drawing submissions shall include as a minimum, but not limited to the requirements stated herein.
- E. Requirements: Provide the following information complete, and in the manner described herein:
1. Hardware, Application Software, and Network Requirements: A system description including analysis and calculations used in sizing equipment required by the security systems. The description shall show how the equipment will operate as a system to meet the performance requirements of the systems. The following information shall be supplied as a minimum:
 - a. Server(s) processor(s), disk space and memory size and/or expansion of existing
 - b. Workstation(s) processor(s), disk space and memory size
 - c. Description of site (field) control equipment (Controllers/Field Panels, NVR's, Modules) and their configuration
 - d. Operating System(s) Software, where software is provided or upgraded
 - e. Application Software, with Optional and Custom Software Modules supplied in this project
 - f. Integration Schemes: Proposed connectivity, software, development requirements, and SDK information, for inter-system communication.
 - g. Network bandwidth and reliability requirements
 - h. Number and location of LAN ports required
 - i. Other specific network requirements, preferences, and constraints
 - j. Backup/archive system size and configuration
 - k. Start-up operations
 - l. System power requirements and Uninterruptible Power Supply (UPS) sizing
 - m. Device/component environmental requirements (cooling and or heating parameters)
 2. Shop Drawings: Shop Drawings shall be numbered consecutively and shall accurately and distinctly present the following information:
 - a. Title Sheet:
 - b. Floor Plans: Showing devices, pull boxes, cabinets, conduits, and conductors in their proposed locations with device numbering scheme.
 - c. Riser Diagram: Showing all conduit relationships between devices shown on the Floor Plans. Show all power sources.
 - d. Single-Line/Block Diagrams: Show signal relationships of controls and devices within the system.
 - e. Custom Assembly Diagrams: For each custom assembly provide an assembly drawing illustrating the appearance of the assembled device. Include dimensions, assembly components, and functional attributes (momentary or alternate action switch, lens color, panel finish)
 - f. Component Connection Diagrams:

- 1) For each equipment component, such as a computer, video switcher, camera or video recorder, show the rear elevation of the device and all connectors/terminations as a pictorial.
 - 2) Show the wire designations on connectors. Typical wiring detail where multiple of same device is provided.
 - 3) Show a schedule of the wire colors connected to the pins on each device connector
- g. Equipment Wiring Diagrams:
- 1) Show a pictorial illustration of each equipment enclosure and/or terminal cabinet, including terminals, components, and wiring devices.
 - 2) Show the device nomenclature exactly as shown on the single line diagrams.
 - 3) Terminations: Show every termination and terminating cable, with applicable cable and wire numbers matching the single line diagrams.
 - a) Every termination in the system must be documented.
 - b) Termination information may be rendered as a wiring list(s), if properly coordinated with, and referenced to, typical component and single-line diagrams. Otherwise, the Shop Drawings shall show a pictorial of every component in the system, with its terminations.
 - 4) Show wire colors for each terminal.
 - 5) For each wire exiting the enclosure, show the destination of the wire by floor, room number and the drawing number of the panel where the wire terminates.
- h. Provide working dimensions and erection dimensions.
- i. Arrangements and sectional views
- j. Necessary details, including complete information for making connections between work under this Contract, existing work, and work under other Contracts.
- k. Stock or standard drawings will not be accepted for review unless full identification and supplementary information is shown thereon in ink or typewritten form.
- l. Duplicate of design drawings may be used where each sheet is modified to reflect contractor coordination, specific requirements of the project and multidiscipline conditions.
- m. Each Drawing or page shall include:
- 1) Project name, Project Number, and descriptions.
 - 2) Submittal date and space for revision dates.
 - 3) Identification of equipment, product, or material.
 - 4) Name of Contractor and Subcontractor.
 - 5) Name of Supplier and Manufacturer.
 - 6) Relation to adjacent structure of material.
 - 7) Physical dimensions, clearly identified.
 - 8) ASTM and Specifications references.
 - 9) Identification of deviations from the Contract Documents.

- 10) Contractor's stamp, initialed or signed, dated and certifying to review of submittal, certification of field measurements and compliance with Contract.
 - 11) Location at which the equipment or materials are to be installed. Location shall mean both physical location and location relative to other connected or attached material.
3. Equipment Submittals
 - a. Provide a Title Page, with project name, Contractors name and address, contact information, date of submission, and submission revision number.
 - b. Provide a Parts List, for proposed equipment, materials, components and devices, listing the following information for each line item:
 - 1) The system type
 - 2) Model number
 - 3) Specification sheet page reference
 - c. Provide Manufacturers Specification Sheet with descriptive information for equipment, materials, components, and devices. Number each page, to correspond with the Parts List.
 - d. Clearly delineate (with highlighter, arrow, or underline) on each specification sheet, specific model numbers, options and configurations being proposed for this project.
 - e. Indicate kinds of materials and finishes for equipment where more than one option is presented.
 4. Acceptance Testing Plan
 - a. Submit a written document detailing the test procedures to be followed in evaluating and proving the installed system(s).
 - b. Provide a sample of the test forms to be used for each system and for each component of each system.
 - c. Include all tests required by the equipment manufacturer and by this Specification.
 5. Spare Parts List: Submit a list of recommended spare parts. Spare parts shall comprise a minimum of 5% or minimum of 2 each of field devices, device termination boards and a minimum of 1 system controller boards.
 6. Training Program
 - a. Submit a training program 10 working days prior to scheduled training to be followed in training key employees in the operation and maintenance of the installed system at the project site. The proposed training program shall be designed to provide a level of basic competence with the system for selected personnel. These selected personnel shall then be expected to train other personnel as required, utilizing the training that they have been given and the body of training documentation provided by Contractor. This plan shall comply with the requirements stated in the "Training" section, of these Specifications, all stated hours of which shall be considered to be classroom hours.
 - b. Submit a curriculum to account for, and relate, each subject to actual training time. All required hours shall be accounted for in this curriculum.
 - c. The training plan shall cover the overall system, each individual system, each subsystem, and each component. The plan shall also cover procedures for

database management, normal operations, and failure modes with response procedures for each failure. Each procedural item must be applied to each equipment level.

- F. The Owner will return unchecked any submittal which does not contain complete data on the work and full information on related matters.
- G. Verification: The contractor shall check and acknowledge all shop drawings, and shall place his signature on all shop drawings submitted to the Owner. Contractor's signature shall constitute a representation that all quantities, dimensions, field construction criteria, materials, catalog numbers, performance criteria and similar data have been verified and that, in his opinion, the submittal fully meets the requirements of the Contract Documents.
- H. Timeliness: The Contractor shall schedule, prepare, and submit a complete shop drawing assembly in accordance with a time-table that will allow his suppliers and manufacturers sufficient time to fabricate, manufacture, inspect test and deliver their respective products to the project site in a timely manner so as to not delay the complete performance of the work.
- I. Departure from Contract Requirements: If shop drawings show departures from the Contract requirements, the Contractor shall make specific mention thereof in his letter of transmittal, otherwise review of such submittals shall not constitute review of the departure. Review of the drawings shall constitute review of the specific subject matter for which the drawings were submitted and not of any other structure, materials, equipment, or apparatus shown on the drawings.
- J. Contractor Responsibility: The review of shop drawings will be general and shall not relieve the Contractor of responsibility for the accuracy of such drawings, nor for the proper fitting and construction of the work, nor for the furnishing of materials or work required by the Contract. No construction called for by shop drawings shall be initiated until such drawings have been reviewed and approved.
- K. Shop Drawing Submittal Review: The procedure in seeking review of the shop drawings shall be as follows:
 - 1. The Contractor shall submit four (4) complete sets of shop drawings with equipment submittals and other descriptive data with one copy of a letter of transmittal to the Owner for review thirty (30) working days after award of the contract. The letter of transmittal shall contain the project name, the Owner's Project Number, the name of the Contractor, the list of drawings submitted including numbers and titles, requests for any review of departures from the contract requirements and any other pertinent information. Drawings submitted for review shall be full-sized drawings, rolled and included with the equipment submittals.
 - 2. Drawings or descriptive data will be stamped "Reviewed", "Furnish as Corrected", "Revise and Resubmit", "Rejected" or 'Submit Specific Item' and one copy with a Letter of Transmittal will be transmitted to the Contractor with the return of submitted documents.

3. If a shop drawing or data is stamped "Reviewed" or "Furnish as Corrected", no additional submittal is required for that shop drawing.
 4. If a shop drawing or data is stamped "Revise and Resubmit" or "Rejected", the Contractor shall make the necessary corrections and resubmit the documents as required above. The letter transmitting corrected documents shall indicate that the documents are re- submittals.
 5. If any corrections, other than those noted by the Owner, are made on a shop drawing prior to resubmittal, such changes should be pointed out by the Contractor upon resubmittal.
 6. The Contractor shall revise and resubmit the shop drawing as required, until they are stamped either "Reviewed" or "Furnish as Corrected."
 7. After the Contractor's submittal or resubmittal of shop drawings, the Owner shall be provided with fifteen (15) working days for review. Should the Owner require additional review time above and beyond the stated fifteen (15) working days, the Contractor may ask for a time extension and/or monetary compensation, if they can present valid, factual evidence that actual damages were incurred by the Contractor. The Owner shall determine the amount of the time extension and/or the monetary compensation to be awarded the Contractor.
 8. The Owner will not issue a "Notice to Proceed" until shop drawings are reviewed, unless otherwise approved by the Owner.
- L. The Contractor shall be responsible for extra costs incurred by the Owner caused by the Contractor's failure to comply with the procedure outline above.

1.14 OPERATING AND MAINTENANCE MANUALS: RECORD DOCUMENTS

- A. Phase One: Notwithstanding requirements specified elsewhere, submit the following labeled as the "Operating and Maintenance Manual" within thirty (30) days after Final Acceptance of the Installation:
1. Record Drawings: Submit two (2) copies of revised versions of drawings as submitted in the "Shop and Field" and "Equipment Wiring Diagrams" Submittals showing actual device locations, conduit routing, wiring and relationships as they were constructed. Include nomenclature showing as-built wire designations and colors. Drawings shall include room numbers coinciding with Owner space planning numbering. Drawings shall be submitted in electronic editable AutoCADfiles, in ".dwg" format, on CD or DVD disks.
 2. Manuals: Submit two (2) copies of each of the following materials in bound manuals, or electronic PDF copies on CD/DVD discs, with labeled dividers:
 - a. A final Bill of Material for each system.
 - b. Equipment Instruction Manuals: Complete, project specific comprehensive instructions for the operation of devices and equipment provided as part of this work.
 - c. Manufacturers Instruction Manuals: Specification sheets, brochures, Operation Manuals, and service sheets published by the manufacturers of the components, devices and equipment provided.

- d. Include information for testing, repair, troubleshooting, assembly, disassembly, and recommended maintenance intervals.
 - e. Provide a replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.
 - f. Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.
 - g. Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturers' Warranty Registration papers as described herein.
- B. Phase Two: Within fourteen (14) days of receipt of engineer reviewed Operating and Maintenance Manual (Phase One), submit three (3) electronic copies in AutoCAD editable dwg. format of the reviewed Record Drawings and three (3) copies of the reviewed Operating and Maintenance Manuals to the Owner, on CD or DVD disks.
- 1. The contractor shall provide to the Owner one (1) copy of new executive and user software, including required graphical maps, on CD-ROM disks.
 - 2. Sufficient information, (detailed schematics of subsystems, assemblies, and subassemblies to component level) clearly presented, shall be included to determine compliance with drawings and specifications.

1.15 CHANGES

- A. Before proceeding with changes or claims for extras, Contractor shall provide written notice, secure prior written approval from the Owner, and substantiate actual cost of each change or claim.

1.16 NOTIFICATION

- A. Contractor shall not shut off any existing systems. Contractor shall give the Owner at least 14 calendar day notice of any requirement to shut off or interfere with existing alarm, access control, regulating, computer or other service systems. The Owner will arrange and execute any shutdown. Work such as splicing, where approved, and connections necessary to establish or re-establish any system shall be completed by Contractor in close coordination with the Owner.

1.17 INTERFERENCE WITH THE FACILITY

- A. Transportation and storage of materials at the facility, work involving the facility, and other matters affecting the habitual use by the Owner of its buildings, shall be conducted so as to cause the least possible interference's, and at times and in a manner acceptable to the Owner. Contractor shall make every effort to deliver equipment per the schedule required by the project.

1.18 WARRANTY

- A. Furnish and guarantee maintenance, repair and inspection service for the system using factory trained authorized representatives of the manufacturer of the equipment for a period of one year after final acceptance of the installation.
- B. Third Party Device warranties are transferred from the manufacturer to the contractor, which may then transfer third party warranties to the Owner. Specific third party warranty details, terms and conditions, remedies, and procedures, are either expressly stated on, or packaged with, or accompany such products. The warranty period may vary from product to product. These products include but are not limited to devices that are directly interconnected to the field hardware or computers and are purchased directly from the manufacturer. Examples may include but not be limited to; servers, cameras, video recorders, card readers, and computers.
- C. Purpose
 - 1. The Contractor shall repair any system malfunction or installation deficiency discovered by the Owner during the burn in and warranty period.
 - 2. The Contractor shall correct any installation deficiencies found against the contract drawings and specifications discovered by the Owner during the warranty period.
- D. The service contract shall cover equipment and software related to this contract, and shall provide for the following parts and services, without additional cost to the Owner:
 - 1. Quarterly Inspection, Preventative Maintenance and Testing of equipment and components
 - 2. Regular Service, Emergency Service, and Call-Back Service
 - 3. Labor and Repairs
 - 4. Equipment and Materials
- E. Response Time: Response time for service calls.
 - 1. Emergency service calls where system is not responding to staff directed commands through the computer systems shall be within 2 hours to the project site.
 - 2. Emergency service calls where controllers are not reporting shall be within 2 hours to the project site.
 - 3. Normal service calls for device malfunctions shall be within 24 hours during normal working hours to the site.
- F. Repair Time: Contractor shall stock parts in sufficient quantities such that repair or replacement shall be guaranteed within 12-hours. Temporary replacements within this time period shall be acceptable, provided temporary replacements do not compromise system functionality, and provided permanent replacement is achieved within 72 hours. Contractor may contact owner for use of owner supplied spare parts where delay of system repair will have negative impact on system performance.
- G. Commencement: The warranty begins at the time of issuance of the statement of "Final Acceptance of the Installation" by the Owner.

- H. Transferability: The warranty shall be transferable to any person or persons at the discretion of the Owner.
- I. Transmittal: A copy of this Warranty shall be delivered to, and signed for by the Owner. A copy of the signed Warranty document shall be delivered for review as part of the Final Submittals.
- J. Registration: Register Warranty papers for all equipment and software in the name of the Owner. Furnish reproductions of all equipment Warranty papers to the Owner with the Final Submittals.
- K. Sub-Contracting: Warranty service work may not be sub-contracted except with specific permission and approval by the Owner.
- L. Resolution of Conflicts
 - 1. The Owner retains the right to resolve unsatisfactory warranty service performance at any time by declaring the work unsatisfactory, stating specific areas of dissatisfaction in writing.
 - 2. If the Contractor or his approved subcontractor does not resolve such stated areas of dissatisfaction within thirty (30) days, the Owner may appoint any alternative service agency or person to fulfill the terms of the Warranty; the cost of which shall be borne by the contractor. This action may be taken repeatedly until the Owner is satisfied that Warranty service performance is satisfactory. Satisfactory resolution of a malfunction shall be considered adequate when the device, equipment, system, or component which is chronically malfunctioning is brought into compliance with the standards of performance as contained herein and published by the manufacturers of the equipment installed.

1.19 PERMITS AND INSPECTIONS

- A. Responsibility: Obtain permits and inspections required for the work. Permit and inspection costs will be borne by the Contractor.
- B. Performance: Perform tests required herein, or as may be reasonably required to demonstrate conformance with the Specifications or with the requirements of any legal authority having jurisdiction.
- C. Review: Obtain approvals from authorities responsible for enforcement of applicable codes and regulations to establish that the work is in compliance with all requirements of reference codes indicated herein and required by the appropriate jurisdiction. Make corrections, changes, or additions as required and deliver certificates of acceptance, operation, and/or compliance with the "Operating and Maintenance Manuals" as described herein.

1.20 TRAINING

- A. On-Site Training

1. General: Present, review and describe equipment and materials to the Owner and Owner's operating personnel and fully demonstrate the operation and maintenance of the systems, equipment and devices specified herein.
2. Training shall comprise two separate levels of training;
 - a. User Group upon substantial completion of the project
 - 1) User group training shall include a site/building walk through indicating locations of equipment and their usage
 - 2) User group training shall include the operation of workstation capability of system monitoring, command override and report generation.
 - b. Maintenance Group upon completion of the project prior to close out
 - 1) Maintenance group training shall include a site/building walk through indicating locations of equipment and their usage
 - 2) Review of as-build documentation at each controller location
 - 3) Trouble shooting techniques in hardware and software
3. The training shall cover the overall system, each individual system, each subsystem, and each component. The training shall also cover procedures for database management, normal operations, and failure modes with response procedures for each failure. Each procedural item must be applied to each equipment level.
4. Duration: Provide at least 2 hours of on-site training on each system for each group of designated representatives of the Owner at a location convenient to the Owner.
5. On-site training shall commence as follows:
 - a. VSS: Just prior to completion of the first phase of work which establishes the new VSS control over video cameras.

1.21 SAFEGUARDS AND PROTECTION

- A. Barriers: Provide and maintain suitable barriers, guards, fences and signs where necessary to accommodate the safety of others relative to and/or for the protection of this work.
- B. Regulations: Comply with OSHA, Federal, State, and local regulations and standards pursuant to this work.
- C. Protection: Protect all materials and equipment to prevent the entry or adhesion of any and all foreign material. If necessary, cover equipment with temporary protective material suitable for this purpose.
- D. Finishing: Check, clean and remove defects, scratches, fingerprints, and smudges if necessary from all equipment and devices immediately prior to Acceptance of the Installation.
- E. Damage: Replace all damaged or defective material or work at no additional cost prior to Final Acceptance.

- F. Documentation: Provide written description of accidents by workers, students and staff of any incident occurring on the project. Report incident in writing to Owner immediately and to the Project Manager for follow up.

1.22 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Unless otherwise noted, pre-testing or configuration is required by the contractor, deliver materials to the job site in manufacturer's original unopened containers, clearly labeled with the manufacturer's name and equipment model identification number.
- B. Storage and Handling: Store and protect equipment in a manner which will preclude damage.

1.23 EQUIPMENT COMPATIBILITY REQUIREMENTS

- A. While individual items of equipment may meet the equipment specifications and in fact meet the system specifications, the total system shall be designed so that the combination of equipment actually employed does not produce any undesirable effects such as signal distortion, noise, transients, or crosstalk interference's when electrically associated with itself or other equipment.

1.24 OWNER'S RIGHT TO USE EQUIPMENT

- A. The Owner reserves the right to use equipment, material and services provided as part of this work prior to Acceptance of the Work, without incurring additional charges and without commencement of the Warranty period.

PART 2 - PRODUCTS

2.1 GENERAL

- A. These general criteria shall apply to "Part 2-Products" of all Security specifications that are a part of this work.
- B. Product Acceptability: Products sections contain lists of Owner acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified. Considerations may include but shall not be limited to functional, physical, aesthetic and/or interface aspects. The Owner shall be the sole judge of whether or not a submitted substitution is deemed to be "equivalent" to that specified.
- C. Manufacturers Specification Reference: Where a specific material, devices equipment or systems are specified directly, the current manufacturers' specification for the same becomes a part of these specifications, as if completely elaborated herein.

- D. Equipment shall be new and the current model of a standard product of a manufacturer of record. A manufacturer of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied.
- E. For each item of equipment offered, manufacturer shall maintain:
 - 1. A factory production line.
 - 2. A stock of replacement parts.
 - 3. Engineering drawings, specifications, operating manuals and maintenance manuals.
 - 4. Manufacturer shall have published and distributed descriptive literature and equipment specifications on each item of equipment offered.
- F. Complete System: Auxiliary and incidental equipment necessary for the complete operation and protection of the systems specified herein shall be furnished and installed as if specified in full.
- G. Similar Devices: Similar devices within a system shall be identical unless specific color variances are required by the Owner or Architect.
- H. Safety: Unless otherwise specified, equipment shall be UL rated individually and listed as an assembly. Electronic equipment shall be of the dead front type, having no exposed live electrical connections, terminals or exposures to hands-on operating surfaces or other exposed surfaces during any power-on condition. Every live electrical connection, terminal or exposure shall be covered with durable, removable insulating material.
- I. Rack Mounting: Rack-mounted electronic equipment shall be specifically designed or modified for standard 19-inch rack mounting unless otherwise noted.
- J. Keying: Key panels identically where provided for similar usage within a system. Coordinate lock types with Owner.
- K. Framing: Floor supported units shall be substantially framed and supported. All bolted connections shall be made with self-locking devices.
- L. Aesthetics: Coordinate console or control panels so that their general appearance is similar. Provide locking panel covers on recessed, semi-recessed and surface mounted control panels not located in equipment rooms. Control panels shall be contained within or mounted to formed and welded aluminum or steel back-boxes. Operating panels shall be recessed within the back-box to a depth sufficient to permit a locking hinge panel cover to close completely without affecting any device within the enclosure.
- M. No contractor proprietary equipment will be permitted without prior approval from the Owner.
- N. Operational Voltage: Devices connected to the fuse or breaker protected electrical system and all auxiliary equipment necessary for the operation of the equipment associated with systems specified herein shall be designed to operate from 105 to 130 volt, 60 Hertz, alternating current service, with stable performance, fully in accordance with these specifications, and shall have integral fuse or circuit breaker protection.

- O. Contractor-fabricated items shall be provided with fuses that indicate when they are blown or defective.
- P. Protection devices shall be located to facilitate replacement, resetting or observation of status without demounting the associated unit and/or de-energizing adjacent equipment.
- Q. Manufacturer's Recommendations: Components and devices shall be operated in accordance with recommendations of the manufacturer and shall contain sufficient permanent identification to facilitate replacement.
- R. Testing Requirements:
 - 1. Equipment, devices, and assemblies shall meet the local city requirements for listing and labeling, which includes UL listing and labeling for manufactured equipment.
 - 2. UL Listing: For devices and assemblies with proper UL listing and labeling, stickers shall be accessible and visible to the Inspectors. Paperwork shall also be available during inspections and shall be provided to the Owner as part of the close out documentation
 - 3. Unlisted Devices and Assemblies: Devices and assemblies without prior listing from testing authorities accepted by the local city, shall be tested by an agency acceptable to the local city prior to inspection, to obtain a listing and label. Documentation on the testing and approval shall be provided to the Owner as part of the close out documentation.

2.2 MISCELLANEOUS PRODUCTS

- 1. Provide Tamperproof security fasteners for the installation of security equipment, cabinets, enclosures and pull boxes in accessible locations. Provide Bryce Fastener PentaPlus series, TP3 style by Tamperproof Screw Company, or equal by Hudson Fastener.
- 2. Provide six (6) compatible screw drivers and transfer to the Owner prior to final acceptance testing.

2.3 TEST EQUIPMENT

- A. The Contractor is responsible for providing test equipment required to test the system in accordance with the parameters specified. Unless otherwise stated, the test equipment shall not be considered part of the system and retain ownership of the equipment. The Contractor shall furnish test equipment of an accuracy better than the parameters to be tested.
- B. The test equipment list shall be furnished as a part of the submittal.
- C. Readiness: Keep test equipment at hand and maintain in calibrated condition at the jobsite as required for routine and performance testing of this work.

PART 3 - EXECUTION

3.1 GENERAL

- A. Perform this work in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.
- B. Aesthetics are an important consideration in this installation. Components shall be installed so as to have aesthetically pleasing results per Owner and Architect requirements. Actual locations of visible components shall be coordinated in advance with Owner and Architect.
- C. The Contractor shall insure that installation personnel understand the requirements of this Specification.

3.2 COORDINATION

- A. General
 - 1. This Contract involves functioning systems. Coordination with the Owner is critical. Do not interrupt any functioning system without complying with the requirements of "Notification" section of this specification.
 - 2. Coordinate the work with the Owner and all trades to assure that where this work interfaces to other trades, those interfaces are provided, complete and functional.
 - 3. Meet with the Owner and each trade. Identify devices needed to complete functional operation of this work which are being provided by Owner, General Contractor or another trade, and assure that the work being provided by others will be acceptable.
 - 4. Make sure work by others is scheduled in order that this work can be installed in a timely fashion.
 - 5. Verify dimensions, and work by others which may be necessary to facilitate the work and coordinate with other trades. Assure that related work by others is coordinated with this work.
 - 6. Verify field conditions. Regularly examine construction and the work of others which may affect the work to ensure proper conditions are provided for the equipment and devices before their manufacture, fabrication or installation. Be responsible for the proper fitting of the systems, equipment, materials, and devices provided as part of this work.
- B. Required Resources: Become familiar with the available access and space for equipment and any potential interference requiring coordination. Coordinate with the Owner to assure that adequate electrical and HVAC, services are available. Provide the physical space for equipment, and ample access room for installation and maintenance of equipment.
- C. Positioning Members: Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Owner without additional expense.

- D. Interface Devices: Provide items necessary to complete this work in conformance with the Contract Documents or the satisfaction of the Owner without any additional expense.
- E. Equipment shall be mounted with sufficient clearance to meet applicable codes and facilitate observation and testing. Securely hang and/or fasten with appropriate fittings to ensure positive grounding, free of ground loops, throughout the entire system. Units shall be installed parallel and square to building lines.
- F. Installation shall comply with "Codes and Standards" section of this specification. Where more than one code or regulation is applicable, the more stringent shall apply.
- G. Where new equipment is replacing old equipment, Contractor is responsible for removing the old equipment and doing repair work necessary to meet standards determined by Owner.
- H. Install fire stopping for penetrations in slabs and firewalls to meet code at the completion of work and prior to final testing demonstration to Owner.
- I. Project Documentation: Review project documentation. If the Contractor perceives conflict or ambiguity in the contract documents, he shall seek interpretation from the Owner. Failure to do so may result in remedial work.
- J. Project Schedule: Immediately obtain and follow the project schedule established by the Owner. Failure to maintain the schedule may result in a requirement by the Owner to expend extra effort until the project schedule has been achieved.
- K. Schedule Changes: Time is of the essence of this agreement. In the event that it becomes necessary for the Contractor to expend "extra effort" to complete the work according to schedule changes not covered above, the Contractor agrees to cooperate with the Owner in good faith to complete the work according to schedule requirements.
- L. Supervision: Maintain a competent supervisor and supporting technical personnel acceptable to the Owner during the entire installation. A change of supervisor during the project shall not be acceptable without prior written approval from the Owner.
- M. Work and Manpower Rules: Comply with applicable jobsite work and manpower regulations.
- N. Found Conflicts: Continuously make known to the Owner, conflicts discovered which may affect the orderly completion or the specified performance of this work. Cooperate with the Owner and other trades to accommodate such changes as may be necessary to resolve found conflicts.
- O. Coordination Difficulties: Promptly notify the Owner in writing of any difficulties which may prevent proper coordination or timely completion of this work. Failure to do so shall constitute acceptance of construction as suitable, to receive this work, except for defects that may develop in the work of others after its execution.

- P. Environmental: Verify the intended location(s) for equipment is suitable for the equipment. If conditions such as temperature, humidity, dust level or the like require modification, make it known to the Owner immediately upon award of the contract. If equipment requires strict environmental conditions (dust limitations, etc.), notify the Owner immediately upon award of the Contract. Failure to notify the Owner of such conditions shall constitute acceptance of the conditions and any later required modifications to the equipment or the environment shall be at the sole cost of the Contractor.
- Q. Extra Effort: The Owner retains the right to require the Contractor to expend whatever extra effort as may be required, in event the Contractor fails to perform satisfactorily at any milestone date, unless such delay is approved in writing by the Owner, or it can be proved by the Contractor that such delay was caused by other contractors, or Owner's intransigence relating to Owner requested changes in the scope of work. Any costs pursuant to such extra effort will be borne solely by the Contractor. If Project Schedule delays are approved, provide the Owner with monthly revisions of the Project Schedule reflecting actual performance vs. the schedule.

3.3 SEISMIC PROTECTION

A. General

1. Seismic protection criteria: Electrical and mechanical machinery installations in any Seismic Risk Zone of the Uniform Building Code Seismic Risk Map shall be protected from earthquakes.
2. Protection criteria for these zones shall be a Horizontal Force Factor not less than required by code or agency, considered passing through the machinery center of gravity in any horizontal direction.
3. Unless vibration isolation is required to protect machinery against unacceptable structure transmitted noise and/or vibration, machinery shall be protected from earthquakes by rigid structurally sound attachment to the load supporting structure. The number shall be determined by calculations performed by a registered California professional engineer, as verified by the seismic restraint vendor.
4. Use protected spring isolators, or separate seismic restraints, to protect vibration isolation machinery.
5. Seismic snubbers and protected spring isolators shall be seismic protection-rated along three principal axes, proven by independent laboratory testing or analysis, by an independent, licensed structural engineer.

- B. The Contractor shall be responsible for the design of his method for seismic restraint systems, and shall supply all seismic calculations and details to the Owner for review. The Contractor shall supply to the Owner details of the forces exerted by his restraints, anchorages, and other points of attachment.

- C. Electrical and mechanical equipment shall be installed in accordance with the following guidelines:

1. SMACNA Publication: Guidelines for Seismic Restraints of Mechanical Systems

2. California Code of Regulations (CCR), Title 24, Division 22
3. NUSIG – National Uniform Seismic Installation Guidelines

- D. Contractor shall submit shop drawings for the mounting of equipment, fixtures, cabinets, consoles, conduit, and cable support racks (where required). These drawings shall be prepared, stamped, and signed by a Registered California Structural Engineer.

3.4 WORKMANSHIP

- A. The installation shall be performed in a professional and workmanlike manner.
- B. On a daily basis, clean up and deposit in appropriate containers debris from work performed under the appropriate Specification sections. Stack and organize parts, tools and equipment when not being used.
- C. Preparation, handling, and installation shall be in accordance with the Manufacturer's written instructions and technical data appropriate to the product specified.
- D. Work shall conform to the National Electrical Contractor's Association "Standard of Installation" for general installation practice.
- E. At the conclusion of the installation, work areas, including panel boxes, shall be vacuumed and cleaned to remove debris and grease.

3.5 EQUIPMENT ENCLOSURES, RACK, AND CONSOLE INSTALLATION

- A. Construction: Coordinate access openings and wire paths through the cabinets for all desk mounted devices
- B. Compliance: Comply with powering, conduit entry and grounding practices as described herein and as required by code.
- C. Coordination of Access: Coordinate the installation of access covers, hinged panels or pull-out drawers to ensure complete access to terminals and interior components. Access shall be designed such that demounting or de-energizing of equipment is not required to gain access to any equipment.
- D. Enclosures: Fasten removable covers containing any wired component with a continuous hinge along one side with associated wiring secured and dressed to provide an adequate service loop. Appropriate stop locks shall be provided to hold all hinged panels and drawers in a serviceable position.
- E. Service Loop: Provide a wiring service loop allowing relocation of termination to any point within the enclosure.

3.6 CUTTING, PAINTING AND PATCHING

- A. Structural members shall not be drilled, bored or notched in such a manner that shall impair their structural value. Cutting of holes in structural members, if required, shall be done with core drills and only with the specific approval of the Owner for each instance. Provide means to identify rebar in slabs prior to drilling.
- B. Walls and other architectural features that require cutting or repair during the installation process shall be returned to their original condition, including the matching of colors, and finishes to the satisfaction of Owner, and at no additional cost to Owner.

3.7 GROUNDING PROCEDURES

- A. Provide grounding of systems and equipment in accordance with manufacturer's recommendations, local electrical codes, and industry standards.
- B. Signal Ground: Signal ground shall be derived from the one main electrical panel which serves all equipment herein.
- C. Grounding procedures for wire, equipment and devices shall be in strict accordance with manufacturers' recommendations and standard installation practices.
- D. Equipment enclosures of an assembly shall be grounded to the single grounding terminal strip of each assembly.
- E. Multiple Powered System Isolation: Where powered devices of the same system exist in two or more locations and a different signal ground exists in each location, the system's communication signal shall be isolated from signal ground at both source and destination ends via modem, fiber optics or other equivalent method.
- F. Contractor shall eliminate or correct potential ground-loop problems in a manner approved by the Engineer.
- G. Shielding: Shielded cables of this section shall be grounded exclusively to Signal Ground. No shields shall be permitted to carry live currents of any kind. Shields shall be tied to Signal Ground at the signal source end only, unless otherwise noted or required by the manufacturer.

3.8 CONDUIT AND WIRE INSTALLATION PRACTICES

- A. Conduit
 - 1. Conduit shall be 1-inch minimum unless noted otherwise on the drawings
 - 2. Wires shall be installed in conduit or in another Owner approved raceway for power and exposed wiring, in areas where mechanical or environmental conditions may damage conductors, and where otherwise specified herein or required by code.
 - 3. Conduit or raceway that is not hidden must have its location and appearance be specifically approved by Owner. If approved, exposed conduit or raceway shall be

run in such a fashion as to make it as inconspicuous as possible. Runs should follow existing building lines and should be square wherever possible.

4. Verify conduit has been installed, de-burred and properly joined, routed, and terminated prior to pulling of cables.
5. Apply a chemically inert conduit lubricant to wire and cable prior to pulling. Do not subject wire and cable to tension greater than recommended by the manufacturer
6. Secure wire and cable runs vertically in conduit for continuous distances greater than thirty (30) feet at the vertical run terminations. Non-coaxial cables shall be secured by screw-flange nylon cable ties or similar devices. Symmetrical clamping devices with split, circular, or other wire conforming, non-metallic bushings shall be provided for other cables.

B. Wiring Without Conduit

1. Wiring may be run in concealed spaces without conduit, in electrical trays, and where otherwise shown on drawings, provided conductors are reasonably protected from mechanical and environmental damage.
2. Any security wiring that is visually exposed must be installed in conduit
3. Conductors run without conduit shall be approved, UL Listed, rated and labeled for Plenum use.
4. Secure wire and cable with approved supports in accordance with the referenced standards and the Authority Having Jurisdiction.
5. Provide cable supports at a minimum of 4-foot intervals.
6. Equipment and devices shall be installed on approved electrical back-boxes. Do not install equipment and devices directly on walls, ceilings, or structural components without back-boxes.
7. Secure cables to cabinets, junction boxes, pull boxes and outlet boxes with approved cable clamps.
8. Independently support cables. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts).
9. Support cable independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
10. Support cable using cable trays, D-brackets, support straps, support wires or other approved cable supports.
11. Fasten cable supports to building structure and surfaces.
12. In shared electrical trays, open ducts, and other cable runs without conduit, separate and strap Access Control cable so that it is clearly distinguishable from all other cables.
13. Clearly mark security system cables at minimum intervals of every 10-feet. Marking shall be with a permanent, printed label, color-coded tag, or other distinguishing marking. Felt tip pen marking on the cable is not acceptable.

C. New Wiring

1. After installation, and before termination, wiring shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors or shields. In

addition, wiring between buildings or underground and all coax cables shall have insulation tested with a megohmmeter and a reading of greater than 20 megohms shall be required to successfully complete the test.

2. Run wires continuously from termination to termination without splices. Splices at junction box locations may be allowed at the discretion of the Owner.
Recommendations for splices at these points shall be established with Owner.
Contractor shall obtain approval from the Owner before proceeding with splices.
3. If splices are required and approved by Owner, the wire shall be joined with solder, then taped or otherwise protected in an approved manner so as to provide mechanical and electrical integrity. Wire nuts and/or electrical tape connections shall not be acceptable. Final connections shall be made at terminal boards with full tagging, labeling and documentation.
4. Water-resistant protection shall be continuous throughout the cable in parking areas, surface conduit, poles, in-slab pull-boxes, in-slab conduit, and underground conduit and pull-boxes, and in any areas subject to moisture and/or water infiltration:
 - a. Splices/Junctions: Provide water-proof protection of splices and junctions, in surface conduit and boxes, in-slab conduit and pull-boxes, underground conduit, and underground pull-boxes, to prevent the entry of moisture or water into cables, splices, or connections.
 - b. Cable Entries: Provide water-blocking sealants at all conduit entries into pull-boxes, junction boxes, back-boxes, cabinets, etc., to prevent the entry of moisture or water into the conduit and cable system.
- D. Boxes: Provide a box loop for wire and cable routed through pull boxes or controller panels. Cable loops and bends shall not be at a radius less than that recommended by the manufacturer. Coordinate pull box size with the Division 26 Contractor as necessary to accommodate this requirement.
- E. Wire Lacing and Dressing: Dress, lace, tie or harness wire and cable vertically, horizontally and at right angles to the enclosure surfaces to prevent mechanical stress on electrical connections as required herein and in accordance with accepted professional practice. No wire or cable shall be supported by a connection point.
- F. Non-Coaxial Connections: Make non-coaxial connections and approved splices within terminal cabinets (except microphone or line level) to screw-type barrier blocks with insulated crimp- type spade lugs. Size all lugs properly to assure high electrical integrity. Connect only one (1) wire per spade lug and not more than two (2) lugs per screw terminal.
- G. Non-Coaxial splicing at device locations to equipment with wire leads shall be made with pre-approved wire Dolphin Connectors.
- H. Shielded Cables: Shielded cables shall be insulated. Do not permit shields to contact conduit, raceway, boxes, terminal cabinets, or equipment enclosures. Tin terminated shield drain wires and insulate with heat shrinkable tubing.

- I. Coaxial Splices: Coaxial splices, if required and approved, shall be on plate mounted dual-barrel type insulated BNC connectors, secured in such a manner that no stress is placed upon the connector.
- J. Unacceptable Conditions: Correct any unacceptable wiring conditions immediately upon discovery, and upon receiving notice to correct.

3.9 BUILDING ATTACHMENTS

- A. Equipment shall be installed level, plumb, parallel, and perpendicular to building structures and to other building systems and components, except where otherwise indicated.
- B. Equipment shall be securely fastened. Select fasteners so that the load applied to any one fastener does not exceed 25 percent of the proof-test load.
- C. Attachment of hanger rods, support cables, diagonal wall bracing, and any other connections made to the building structure after the fireproofing contractor has completed his work, shall be made with minimal impact to the existing fireproofing. The Contractor making such connections is responsible for:
 - 1. Removal of fire stopping where attachment is required.
 - 2. Scorings and over-cut as required for connection only. Contractor shall be held responsible for costs associated with the patch back of excessively removed fire stopping material by the General Contractor.
- D. Due to the nature of the site, all surface mounted/exposed conduit (EMT and liquid-tight flex) and backboxes shall be fixed to the buildings with no hanging parts.

3.10 DATABASE PREPARATION, CHECKING AND ACTIVATION

- A. Contractor to request Owner provided forms with completed nomenclature for each identified device no less than 30 days prior to programming. It is essential that the above activities be clearly identified on the Project Schedule so database preparation is accomplished in sufficient time to permit orderly and on time system activation
- B. It shall be the responsibility of the Owner to insure the accuracy of the database information entered on forms by thoroughly checking completed data entry forms.
- C. It shall be the responsibility of Contractor to ensure that the database formatting is correct prior to entry into the system and system activation.
- D. Programming
 - 1. The Contractor shall be responsible for the initial database entry for devices and equipment installed in this project into the existing system prior to activation. Location of program database entry to be confirmed with the Owner. The database shall consist of hardware and function-related information, i.e., system configuration, alarm points, software parameters for system management, graphical maps, alarm

information – access levels and schedules. A printout of the final database shall be provided to the Owner for review and approval prior to system activation.

2. Programming rights shall be provided the Owner. Contractor shall coordinate with the Owner prior to the completion of installation to set a schedule for access to programming resources.
3. Follow all procedures and protocols for programming the system, in accordance with Owner instructions.

- E. System activation shall be the responsibility of Contractor. Once the system and database have been demonstrated to be functioning properly according to manufacturer's guidelines and the system design, further database entries and upgrades shall be the responsibility of Owner, unless otherwise noted.

3.11 SOFTWARE UPGRADES

- A. If more recent versions of the operating system or application software are made available to or requested by the Owner prior to system acceptance, these updated versions shall be installed and verified by Contractor.
- B. Before installing upgrade software, Contractor shall ensure that existing database information is properly "backed-up" prior to any installation action.

3.12 START-UP RESPONSIBILITY

- A. Contractor shall initiate System Operation. Competent start-up personnel shall be provided by Contractor on each consecutive working day until the System is functional and ready to start the acceptance test phase. If in Owner's judgment Contractor is not demonstrating progress in solving any technical problems, Contractor shall supply Manufacturer's factory technical representation and diagnostic equipment at no cost to Owner, until resolution of those defined problems. Where appropriate, Contractor will bring the System on-line in its basic state (i.e., alarm reporting, etc.).
- B. Properly ground each piece of electronic equipment prior to applying power.
- C. Properly ground all shielded wire shields to the appropriate earth ground at the hub end only, not at the remote or device end.
- D. Use a start-up sequence that incrementally brings each portion of the system on-line in a logical order that incorporates checking individual elements before proceeding to subsequent elements until the entire system is operational.

3.13 PRELIMINARY, INSPECTION, ACCEPTANCE TESTING, AND COMMISSIONING

- A. Provide Preliminary Testing, Inspection, Acceptance Testing, Burn-In and Commissioning Performance services for systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.

3.14 FINAL PROCEDURES

- A. Portable Equipment: Furnish portable equipment specified herein to the Owner, along with complete documentation for the materials furnished. Portable equipment shall be presented in the original manufacturer's packing, complete with manufacturer's instructions, manuals and documents. Testing of portable equipment shall have been previously conducted by the Contractor.
- B. Post Acceptance Work: Check, inspect and adjust systems, equipment, devices, and components specified, programming updates, at the Owner's convenience, approximately sixty (60) days after Acceptance of the Installation.

3.15 NOTICE OF COMPLETION

- A. When the performance and acceptance requirements described above, including the Final Acceptance Test, have been satisfactorily completed, the Owner shall issue a Letter of Completion to Contractor indicating the date of such completion. The Notice of Completion shall be recorded by Contractor upon receipt of the Owner completion letter. This date of record shall be the start of the warranty period.

END OF SECTION

SECTION 28 05 53 – IDENTIFICATION FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This specification section covers the furnishing and installation of nameplates, labels, wire markers, and other identification components for security systems.
- B. Contractor shall furnish and install identification devices as specified on cables, cabinets, racks, and equipment.

1.2 PRECEDENCE

- A. Obtain, read, and comply with General Conditions and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable sub-section and directions as contained herein, this section shall govern.

1.3 GENERAL CONDITIONS

- A. In accordance with Section 28 05 00, Security System General Requirements

1.4 RELATED WORK

- A. Drawings and general provisions of the Contract, including General Conditions and Standard Guidelines referenced in Division 01 Summary Section, apply to this Section.
- B. In accordance with Section 28 05 00, Security System General Requirements
- C. In accordance with Section 28 08 00, Security System Testing, and Commissioning
- D. In accordance with Section 09 90 00, Paints and Coatings

1.5 SHOP DRAWINGS & EQUIPMENT SUBMITTALS

- A. In accordance with Section 28 05 00, Security System General Requirements
- B. Product Data:
 - 1. Submit manufacturer's catalog literature for each product required.
 - 2. Submit identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

1.6 WARRANTY

- A. In accordance with Section 28 05 00, Security System General Requirements

1.7 REQUIREMENTS FOR IDENTIFICATION AND TAGGING

- A. Cables, wires, wiring forms, terminal blocks, and terminals shall be identified by labels, tags or other permanent markings. The markings shall clearly indicate the function, source, or destination of all cabling, wiring and terminals. The wire marking format contained in the shop drawings shall be utilized for conductors installed under this Specification. Cables and wires shall be identified, utilizing heat-shrink, machine-printed, polyolefin wire markers (Hand written tags or marker on wiring is not acceptable.)
- B. Should a situation arise where the wire tagging format as shown on the shop drawings cannot be used, a substitute format shall be submitted which complies with the intent to provide documentation that will permit end-to-end tracing of all System wiring.
- C. Terminal points shall be appropriately identified and labeled as shown on shop drawings.
- D. Nameplates – General:
 - 1. Provide laminated, engraved plastic nameplates with 3/8-inch-high letters for all panels, enclosures and cabinets. Attach nameplates to gear with sheet metal screws where applicable. Adhesive mounted nameplates are generally not acceptable.
 - 2. Include nameplate schedule on shop drawing submittals.
 - 3. Install nameplates behind panel door in public areas and on panel face in equipment rooms.
 - 4. Nameplate Color Schedule:
 - a. Fed from Normal Building Power: Black letter on White label
 - b. Fed from Emergency/ Generator Power: White letters on Red label
- E. Panels shall be provided with permanently attached engraved lamacoid labels, as described in Item D, with identifying names and functions. Labels shall be consistent in form, color, and typeface throughout the system and must contain the name of the system or subsystem as part of the label textual information. Hand written tags or marker type identification is not acceptable.
- F. Equipment/Equipment Racks: Provide an engraved lamacoid label, as described in Item E, on the front of equipment including its designation as assigned and referenced consistently throughout this project.
- G. Enclosures and Cabinets:
 - 1. Provide an engraved lamacoid label, as described in Item E, on the front of wall mounted control enclosures and equipment racks including its designation as assigned and referenced consistently throughout this project.
 - 2. Within each equipment enclosure and/or terminal cabinet, the contractor shall place a Single Line drawing of the system(s) and the respective Equipment/Terminal

Cabinet Wiring Diagram in a clear plastic 8" x 11" sleeve permanently attached to the inside cover of the terminal cabinet. Drawings shall include cable and equipment label designations to match the labeling within the cabinet.

3. In each equipment enclosure, the contractor shall place an as-built drawing depicting device locations served by the equipment within the enclosure, with identification that is identical to the wiring tags and with the software description of each point.

- H. Wire and Cable: Identify wire and cable clearly with permanent labels wrapped around the full circumference within one-inch of each connection. Correlate the number designated on the associated Shop or Field Drawings. Assign wire or cable designations consistently throughout a given system. Each wire or cable shall carry the same labeled designation over its entire run, regardless of intermediate terminations.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Product Acceptability: The Products section contains lists of acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified and compatible with the existing system. Considerations may include but shall not be limited to functional, physical, aesthetic and/or interface aspects. The Owner shall be the sole judge of whether or not a submitted substitution is deemed to be "equivalent" to that specified. Contractor may not use contractor proprietary interface modules for connections between field devices and controller.
- B. Labeling:
 1. Provide intelligible permanent engraved identification function on or adjacent to panel assemblies, power supplies, and cabinets.
 2. Provide intelligible permanent label-maker labels for relays, controls, fuses and/or circuit breakers, patching jacks, connectors, receptacles, terminal blocks, indicators, switches, monitors, and servers.
 3. Labels shall be machine-printed. Hand-lettered labels shall not be acceptable.
- C. Engraving, labels, decals or other identification on any device, equipment or miscellaneous component shall be coordinated with the associated Field and Shop and Equipment Wiring Drawings.
- D. No proprietary identification on assemblies will be permitted other than the original manufacturer's labels and identification.

2.2 MISCELLANEOUS PRODUCTS

- A. Wire and Cable Labels: Provide Brady Type B-321, dot matrix and thermal transfer printable sleeves, with permanent ink ribbon printing, or Thomas and Betts EZ-W/YHS, or equal. Sleeves shall be constructed of heat shrinkable, high density polyolefin film

coated and shall have an ink-receptive top-coating. Labels shall be pre-printed to match the designations shown on the shop drawings, fitted to cables in the field, and heat shrunk to secure their position. Labels should be placed such that they are easily accessed and readable after the device or panel is fully dressed.

- B. Equipment Labeling: Unless otherwise noted herein, provide Laminated three-layer plastic with engraved black letters on white background color. Minimum thickness shall be 1/8". Letter size shall be 3/8"-1/2" for equipment and controls.
- C. Cabinet/Enclosure Labeling: Unless otherwise noted herein, provide Laminated three-layer plastic with engraved black letters on white background color. Minimum thickness shall be 1/8". Letter size shall be 1/2" minimum.

PART 3 - EXECUTION

3.1 GENERAL

- A. In accordance with Section 28 05 00, Security System General Requirements.

3.2 LABEL AND NAMEPLATE INSTALLATION PRACTICES

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.
- C. Install identifying devices after completion of painting and finishes.
- D. Nameplate Installation:
 - 1. Install nameplate parallel to equipment lines.
 - 2. Install nameplate for each control equipment enclosure with corrosive-resistant mechanical fasteners.
 - 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
 - 4. Secure nameplate to equipment front using screws.
- E. Wire Marker Installation:
 - 1. Install wire marker for each conductor at each connection.
 - 2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
 - 3. Install labels at data outlets identifying patch panel and port.

3.3 PRELIMINARY INSPECTION AND TESTING

- A. Provide preliminary inspection and testing services for systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.

3.4 FINAL PROCEDURES

- A. Perform final procedures in accordance with section 28 05 00, Security System General Requirements.

END OF SECTION

SECTION 28 08 00 – SECURITY TESTING AND COMMISSIONING

PART 1 - GENERAL

1.1 WORK INCLUDES

- A. General Description: This specification section covers the provision of preliminary testing, acceptance testing, burn-in performance testing, and the commissioning of various security systems at LAC facilities.
- B. Provide Testing to assure that electrical equipment and wiring is operational, within industry and manufacturers tolerances and is installed in accordance with other sections of these specifications.
- C. Conduct tests in the presence of the Owner and the Owner's agents for the purpose of demonstrating the equipment or systems' compliance with specifications. Demonstrate electrical and mechanical tests to the Owner and the Owner's agents that the entire installation is functioning properly and that circuits, including power, control, instrumentation, relaying, integration, and communication, will function properly and as specified.
- D. Furnish, install and maintain tools, instruments, material, test equipment, test connections and power. Furnish personnel including supervision and "stand-by" labor required for the testing, setting, and adjusting of electrical facilities and component parts including putting the above into operation.
- E. Make tests with proper regard for the protection of equipment and personnel.
- F. Protect equipment from subsequent testing of other equipment and systems after equipment has been tested, checked for operation, and accepted by the Owner.
- G. Record test values of equipment, giving both "as-found" and "as-left" for existing conditions.
- H. The witnessing of any test by the Owner does not relieve the Contractor of warranties for material, equipment, and workmanship, as specified in the General Conditions.
- I. Check circuits for conformance with the wiring diagrams furnished by manufacturers.

1.2 RELATED SECTIONS AND REFERENCES

- A. Drawings and general provisions of the Contract, including General Conditions and Standard Guidelines referenced in Division 01 Summary Section, apply to this Section.
- B. In accordance with Section 28 05 00, Security System General Requirements

- C. In accordance with Section 28 05 53, Identification for Electronic Safety and Security
- D. In accordance with Section 28 23 00, Video Surveillance System
- E. Inspections and tests shall be performed in accordance with applicable codes and standards including the most current versions of NEC, ANSI, IEEE, NFPA, NEMA and OSHA.
- F. International Electrical Testing Association, Acceptance Testing Specifications (NETA ATS), latest edition.

1.3 SUBMITTALS

- A. In addition to the requirements of Section 28 05 00, four (4) bound copies of the certified test reports shall be submitted to the Owner within seven (7) days after the completion of the work. The final report shall be signed and include the following information:
 - 1. Summary of the project.
 - 2. Description of the equipment tested.
 - 3. Visual inspection report
 - 4. Description of the tests
 - 5. Pre-Acceptance and Final Acceptance Test results
 - 6. Conclusions and recommendations
 - 7. Appendix including appropriate test forms
 - 8. Identification of the test equipment used

1.4 WARRANTY

- A. Provide the work in accordance with Section 28 05 00, Security Systems General Requirements.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL

- A. Furnish labor, instruments, products, temporary power, and sufficient materials required for testing at each test.

- B. Correct deficiencies found as a result of tests and make replacements or repairs to tested products that are damaged as the result of the tests. This included Burn In Performance report reviews
- C. Schedule tests at a time convenient to witnesses thereto or persons affected by the tests.
- D. Provide fourteen (14) day written notification to the Owner for test procedures prior to the test.
- E. Make records of all tests in a neat and legible form. Identify the equipment or system tested and the test data.
- F. Check control, instrumentation, and power cables and conductors for proper connections, workmanship, and identification.
- G. Test disconnect switches through an open and closed cycle for proper operation, alignment, and contact.
- H. Additional tests required shall be as outlined under the various Sections of Division 26 and 28.
- I. Submit to the Owner certified reports on all tests indicating full compliance with test requirements.

3.2 COORDINATION

- A. Provide the work in accordance with Section 28 05 00, Security System General Requirements.

3.3 WORKMANSHIP

- A. Provide the work in accordance with Section 28 05 00, Security System General Requirements.

3.4 PRELIMINARY INSPECTION & TESTING

- A. Coordination: Coordinate testing of components of the system in cooperation with other trades.
- B. Verification: Prior to performing Preliminary Testing, inspection, and/or final testing procedures, Contractor shall insure the following:
 - 1. Safe and proper operation of all components, devices or equipment, and the absence of extraneous or interfering signals
 - 2. Proper grounding of devices and equipment
 - 3. Integrity of signal and electrical system ground connections
 - 4. Proper powering of devices and equipment

5. Integrity of all insulation, shield terminations and connections
 6. Integrity of soldered connections and absence of solder splatter, solder bridges, debris of any kind
 7. Proper dressing of wire and cable with labels matching as-build documents
 8. "Wire-checking" of all circuitry, including phase and continuity
 9. Preliminary targeting and setup of video camera assemblies
 10. Mechanical integrity of all support and positioning provisions, i.e.: as provided for video cameras, monitors, and any other equipment
 11. Sequencing: If applicable, determine and record the sequence of energizing systems to minimize the risk of damage from improper startup
 12. Proper operation of devices and systems in accordance with specified performance requirements
 13. System is programmed for alarm reporting of each device and associated with the graphical maps
 14. Verify system programming is defined.
 15. Verify with Owner the provided designations for all devices.
- C. Perform a Preliminary Inspection and Test to determine the operating status of components and systems prior to Final Acceptance Testing.
1. Testing Security Equipment, Enclosures, and Cabinets
 - a. Test each power supply battery or UPS for power loss alarm reporting
 - b. Test 120VAC power loss alarm
 - c. Test for communication loss with server reporting
 2. Test power stand-by provisions (UPS, battery backup, generator backup)
 3. Testing Video Surveillance System
 - a. Live viewing
 - 1) Verify each camera live viewing at the monitoring workstation is in focus
 - 2) Verify each camera live viewing at Central Command Post is in focus
 - 3) During an alarm event verify camera and pre-programmed views associated with alarm event are displayed at the viewing location(s)
 - 4) Verify camera identification match Owner defined description.
 - b. Recorded Images
 - 1) Verify each camera viewing of recorded images at the monitoring workstation
 - 2) Verify each camera viewing of recorded images at Central Command Post
 - 3) Verify alarm event is recorded as specified in 28 23 00
- D. Adjustments and Documentation: After successfully energizing and testing the systems, make adjustments, and document the setting of controls, configurations, as applicable. Tabulate all data along with an inventory of test equipment, a description of testing conditions and a list of test personnel.

- E. Test Documentation: Create and provide complete test reports documenting the results of the each performed on each device, control panel, power supply, and other elements of the system. Copies of preliminary test data shall accompany copies of performance testing data as part of the Operating and Maintenance submittal.

3.5 PREPARATION FOR ACCEPTANCE (PRIOR TO FINAL INSPECTION)

- A. Temporary facilities and utilities shall be properly disconnected, removed, and disposed of off-site.
- B. Systems, equipment, and devices shall be in full and proper adjustment and operation, and properly labeled and identified.
- C. Materials shall be neat, clean, and unmarred, and parts securely attached.
- D. Broken work, including glass, raised flooring, and supports, ceiling tiles and supports, walls, doors, etc., shall be replaced or properly repaired, and debris cleaned up and appropriately discarded.
- E. Extra materials as specified shall be delivered and stored at the premises as directed by the Owner at the completion of the phase.
- F. Preliminary Test reports of each system and each system component, and Record project documents shall be complete and available for inspection and delivery upon completion of each phase as directed by Owner.

3.6 ACCEPTANCE TESTING AND ADJUSTING PROCEDURES

- A. Purpose: Conduct testing and adjusting procedures to realize and verify the performance criteria specified herein and identified in Preliminary Testing procedures listed above. Successfully demonstrate the acceptable performance of each specified system in the presence of the Owner and Engineer.
- B. Scope: Conduct all performance testing, adjustment, and documentation procedures to verify and realize compliance with the performance specifications herein. Make available at least one (1) engineer familiar with this work, and all required test equipment for the duration of performance testing verification, at the convenience of the Owner.
- C. Acceptance Testing Readiness: Acceptance testing will be performed after the system is installed and pre-tested completely.
 - 1. The contractor shall have successfully tested the system prior to scheduling formal acceptance testing and provided forms with each test for each portal. Contractor shall correct any and all deficiencies found at that time.
 - 2. Acceptance testing will be conducted in accordance with the approved Acceptance Testing Plan with a minimum of testing listed in Preliminary Testing section.
 - 3. Deliver equipment, devices and materials required for the work to the site at least fourteen (14) working days prior to the scheduled Completion Date.

4. Install, test and ready all of the work for final Acceptance Testing of the Installation ten (10) working days prior to the Completion Date.
- D. Acceptance Testing Schedule: Contractor shall confirm in writing to the Owner when the system is ready for acceptance testing. Contractor shall then schedule a complete Acceptance Test at the convenience of the Owner.
- E. Acceptance Testing
 1. Contractor shall test and verify the performance of all equipment, systems, interfaces and peripheral equipment in the presence of the Owner and Engineer.
 2. Tests shall be performed in accordance with the requirements of individual systems as specified herein and in related specification sections. Test shall incorporate testing described in preliminary inspection and testing.
 3. Contractor shall furnish communication equipment between the field testing team and the monitoring team.
 4. Contractor shall furnish testing forms for each location.
- F. An Observation Report will be generated by the reviewing team, Owner, Design Engineer and Contractor for contractor to review.
- G. Correction of Jobsite Observation Report Items: Perform any and all remedial work to correct inadequate performance or unacceptable conditions of, or relating to any of this work, as determined by the Owner within ten (10) working days of the completion date. Corrective work shall be performed at no additional cost to the Owner. Contractor shall provide a written report each week of repairs made and plan to complete repairs in progress.
- H. Test Documentation: Document all acceptance testing, calibration and correction procedures described herein with the following information:
 1. Performance date of the procedure
 2. The names of personnel conducting the procedure
 3. The equipment used to conduct the procedure
 4. Type of procedure and description
 5. Condition during performance of procedure
 6. Parameters measured and their values, including values measured prior to calibration or correction as applicable

3.7 BURN-IN PERFORMANCE PERIOD

- A. Prior to Final Acceptance by the Owner, the Contractor shall be responsible for performing testing and inspections, as specified herein, to verify that the installation equipment and materials are performing in compliance with the specifications.
- B. Upon satisfactory completion of Acceptance Testing and inspection, the Owner shall notify the Contractor, and the Burn-In Performance Period shall commence.

- C. Contractor shall obtain weekly reports of alarm events related to this project and make system repairs or corrections to minimize false alarms. A report shall be provided by the Contractor to the Owner indicating corrections required and locations corrected. Engineer may provide additional comments to the report for contractor to review and provide corrective action.
- D. A Performance Period of thirty (30) consecutive calendar days of operating without fault in accordance with the specifications, subsequent to testing and inspection, shall constitute a successful Performance Period.
- E. Upon successful completion of the Performance Period, the Owner and design team shall meet to confirm Acceptance, and the Final Acceptance Form shall be executed.
- F. If a successful Performance Period cannot be accomplished within ninety (90) consecutive calendar days after commencement of the first Performance Period, the Owner reserves the right to find the Contractor in default, and terminate the Contract. In that event, the Contractor shall remove the equipment, and the Owner shall not be responsible for any payment whatsoever to the Contractor, except for any materials (i.e., wiring) left in place and elected to be reused by the Owner.
- G. Obtain system alarm and event reports at a minimum of four (4) times during the burn in period. Review reports with Owner and repair system equipment and/or adjust system parameters as requested by the Owner or required for system performance.

3.8 COMMISSIONING AND VALIDATION

- A. Commissioning is a “fine tuning” process used for complex systems that occurs after acceptance testing, during the Burn-In Performance period and before final acceptance.
- B. This process includes participation by the Owner, Contractor, the Consulting Engineer, A third party testing agent may also be hired by the Owner to plan, conduct, and verify the Commissioning process.
- C. The Contractor shall include a minimum of sixteen (16) hours of participation in the commissioning and validation process by a minimum of two (2) employees familiar with the specific project and installation. Contractor shall adjust device installation where alarms are determined to be false.
- D. Scheduling of Commissioning and Validation testing will be by the Owner, and may occur after the Notice of Completion, but before the end of the Warranty period.
- E. Revisions to the configuration and programming of the system which are recommended by the Commissioning Team as a result of validation testing, shall be performed by the Contractor under the direction of the Owner, at no additional charge. The Warranty provisions of this specification shall apply to any configuration and programming revisions resulting from the validation testing process.

- F. Revisions and improvements recommended by the Commissioning Team which require physical modifications or additions to the approved and accepted system, including the provision or relocation of new equipment, wiring, and installation, shall be treated as additional changes to the contract, and shall be processed as defined in the Project General Provisions. Where such requested work was part of the Contractors' original scope of work, as defined in the design drawings and specifications, or in contract revisions and agreements, the Contractor shall provide the work at no additional charge.

3.9 FINAL PROCEDURES

- A. Perform final procedures in accordance with Section 28 05 00, Security System General Requirements.

END OF SECTION

SECTION 28 23 00 – VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General Description: This specification section covers the furnishing and installation of a complete expansion to a low-voltage, enterprise-wide video surveillance system (VSS).
- B. Contractor shall furnish licenses and install VSS hardware devices, mounting brackets, power supplies, servers, workstations, recorders, controls, consoles and other components of the system as shown and specified.
- C. Furnish and install special boxes, cable, connectors, wiring, and other accessories necessary to complete the system installation. Requirements shall be in accordance with the Division 26, Electrical Work.
- D. Outlets, junction boxes, pull boxes, conduit, connectors, wiring, and other accessories necessary to complete the system installation, will be provided in accordance with the projects' Division 26, Electrical Work specifications, and coordinated with VSS requirements.
- E. General Conditions: Provide the work in accordance with Section 28 05 00, Security System General Requirements.

1.2 QUALIFICATIONS

- A. Provide the work in accordance with Section 28 05 00, Security System General Requirements.

1.3 GENERAL CONDITIONS

- A. In accordance with Section 28 05 00, Security System General Requirements

1.4 RELATED WORK

- A. Drawings and general provisions of the Contract, including General Conditions and Standard Guidelines referenced in Division 01 Summary Section, apply to this Section.
- B. In accordance with Section 28 05 00, Security System General Requirements
- C. In accordance with Section 28 05 53, Identification for Electronic Safety and Security
- D. In accordance with Section 28 07 00, Security System Integration

- E. In accordance with Section 28 08 00, Security System Testing and Commissioning
- F. In accordance with Section 28 23 00, Video Surveillance System

1.5 APPLICABLE PUBLICATIONS

- A. In accordance with Section 28 05 00, Security System General Requirements

1.6 PRECEDENCE

- A. Obtain, read and comply with General Conditions and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable sub-section and directions as contained herein, this section shall govern.

1.7 SHOP DRAWINGS & EQUIPMENT SUBMITTAL

- A. In accordance with Section 28 05 00, Security System General Requirements

1.8 OPERATING AND MAINTENANCE MANUALS

- A. In accordance with Section 28 05 00, Security System General Requirements

1.9 WARRANTY

- A. In accordance with Section 28 05 00, Security System General Requirements

1.10 SERVICE AND MAINTENANCE

- A. In accordance with Section 28 05 00, Security System General Requirements

1.11 TRAINING

- A. In accordance with Section 28 05 00, Security System General Requirements

1.12 OWNER'S RIGHT TO USE EQUIPMENT

- A. The Owner reserves the right to use equipment, material and services provided as part of this work prior to Acceptance of the Work, without incurring additional charges and without commencement of the Warranty period.

1.13 TECHNICAL REQUIREMENTS, VIDEO SURVEILLANCE SYSTEM

- A. General

1. The following information is provided to establish required system performance for the complete operating Video Surveillance System (VSS) system. Some of the performance requirements noted herein are supported and supplied by existing systems in concert with new equipment and software which shall be provided by the Contractor under this scope of work. Contractor shall provide equipment, wiring and software programming at all sites as necessary to provide a complete system as described herein and as shown on the drawings.
2. Contractor shall be responsible for providing equipment, licenses and software to achieve the specified system performance described herein.
3. Contractor shall ensure system additions and modifications provided under this scope of work have no negative effect on the existing systems and operations, and no permanent effect beyond that specified or implied by the scope of work unless otherwise noted herein.

B. Purpose

1. The System shall provide the ability to record images received from cameras located throughout LAC probation camp facilities in a digital format.
2. The System shall allow operators to view live and recorded video images in single and multiple-camera formats based on parameters requested by the user.

C. Environment

1. The system shall be wholly contained within the facilities shown on the plans.
2. Video Processing and Recording Components: Network Video Recorders (NVR) shall be centralized as shown on the plans.
3. Building Administrative Post: Where applicable, Video Client workstations shall be located as shown on the drawings. Site surveillance, site camera configuration, and review of recorded images shall occur at this location.
4. Infrastructure and Connectivity
 - a. The video camera and processing components at each site shall utilize a combination of standard copper cable, fiber optic cable, IP or wireless transmission schemes, depending on individual site conditions.
 - b. Local Sites: The wired network cameras, video encoders, network video appliances, and Client Workstations shall reside on the building's local area network (LAN) or network segment. Recording, live viewing, switching, long-term storage, reviewing, and configuration shall be implemented over this infrastructure. Coordinate LAN/WAN requirements for this project with the Owner and IT Contractor.

D. Attributes

1. General
 - a. The Digital Video Management System (DVMS) is new.
 - b. The system shall comprise network video appliances, video clients, digital storage devices, router/switches, and ancillary equipment assembled into a fully operating system.

- c. Field Components: Field Components shall comprise video cameras, positioning devices, lenses, camera mounts and housings, and other video system devices and wiring as described herein and shown on the drawings.
 - d. Video Processing Components: Video processing components shall comprise computer video servers, encoders / decoders, digital storage devices, computer video monitoring stations, and other video processing devices as described herein and as needed to provide the required functionality.
 - e. Quality: The initial quality/compression parameters shall be set as determined by the Engineer and the Owner at the time of commissioning. Minimum video quality shall be equivalent to 4k, or the selected camera's highest supported resolution, unless otherwise approved by the Owner.
2. Integrated Digital Video Management System
- a. The Contractor shall incorporate the following application software features and functionality into the new work, and configure the system and devices to make use of these and any other features offered by the application software, as required by the Owner.
 - b. The VSS shall support an integrated Digital Video Management recording solution utilizing a Network Video Recorder (NVR) appliance that provides the following features and capabilities:
 - 1) The VSS shall support Digital Network Video Recorders manufactured by the VSS manufacturer and from third party manufacturers.
 - 2) The VSS/EACS shall support analog and IP video sources
 - 3) The Digital Video Management Software (DVMS) shall incorporate a modular architecture and be able to support an unlimited number of cameras
 - 4) The DVMS shall be able to simultaneously record and display live video and display recorded video
 - 5) The DVMS shall support both event based and continuous recording
 - 6) The DVMS shall mark all events and they shall be available for playback and or archiving at any time
 - 7) User defined profiles for tailored granular access to configuration and operation
 - 8) Independent camera setup for, compression rate, brightness, contrast and other factor setups.
 - c. DVMS Network Interface
 - 1) The network interface shall allow remote access of the DVMS from anywhere with established connectivity on the LAN/WAN.
 - 2) The DVMS shall have the ability to playback stored video over the LAN / WAN for remote access of video images.
3. Real Video Time Monitoring: The DVMS / IPDVMS shall allow monitoring of real time video from any Alarm Monitoring client workstation. DVMS and Camera status shall be displayed on a System Hardware Tree.
4. Matrix View: The DVMS / IPDVMS shall support an advanced Matrix View of On-line camera views. Up to 32 channels shall be able to be simultaneously displayed in the video matrix. The 32 channels shall be any combination of Live or Recorded video.

5. Pan / Tilt / Zoom Control from Alarm Monitoring: Video cameras so equipped, shall be capable of pan/tilt/zoom positioning and remote control functions. Video camera positioning and imaging signals shall be transmitted by LAN networks as described herein, to permit remote viewing and camera control "on demand" on any LAN-connected device, from any location, with appropriate software and authorization.
6. Still Image Capture / Save: During playback or monitoring of video, the System shall have the ability to create and save a still picture.
7. Export Video Clip to File: The VSS shall have the ability to save and export recorded video to a file for the purpose of sharing and reviewing video clips. The start and end times for each video segment shall be user defined.
8. Video Loss Detection: The VSS shall detect video loss from cameras and activate an alarm.
9. Automated Motion Video Searching

E. Functional Requirements

1. Video Recording Protocols: Initially, configure the system as directed by the Owner, based on the following recording protocol definitions:
 - a. Recording Modes:
 - 1) Time Lapse Mode: 8 frames per second (fps) per camera. Cameras shall be continuously recorded at this rate. (15 fps on motion)
 - a) Applies to all exterior cameras and Max Security Dorm interior cameras.
 - 2) Real Time Mode: 30 fps per camera
 - 3) Event/Alarm Mode: 15 fps per camera (or camera's highest FPS if below 15fps)
 - a) Applies to interior cameras except Max Security Dorm.
 - b. Compression Codec: H.264 or better
 - c. Compression Quality: Compression rates shall always be set at their highest quality. Automatic throttling can be used where network bandwidth is restricted, when approved by the Owner.
 - d. Resolution: Cameras should be configured to deliver streams in their highest native resolution.
 - e. Motion-Based Recording Modes: Motion detection recording modes may be implemented where directed by the Owner, but assumptions on motion cannot be used to calculate storage capacity.
2. Recording and Retrieval
 - a. Provide a minimum hard-disk storage capacity of 365 days of recording, for cameras installed as a part of this project. Storage media shall be located in the security equipment room, communications room, security monitoring center, or where shown on the plans. Storage capacity shall be calculated based on the following parameters:
 - 1) Time Lapse Mode (8 frame per second (fps) per camera, high-quality compression): 24-hours per day, 7-days per week, at highest native resolution, plus;

- 2) Real-Time Mode (30fps per camera at high-quality compression): 10% of the total number of cameras, 2-hours per day, 7-days per week, at highest native resolution.
 - 3) Assume 100% motion and complexity within the viewing area at all times for storage calculations.
 - b. Storage Locations
 - 1) Admin Building MDF
 - a) This will house the primary storage recorders.
 - b) Provide 365 days of storage within this MDF.
 - 2) Staff Quarters MDF
 - a) This will house the secondary storage recorders.
 - b) Provide 120 days of mirrored recording from primary recorders.
3. Forensic Recording: Provide a means of recording video clips for transport such as DAT, DVD or DVD-ROM, for forensic and evidentiary purposes.
4. Software routines required to accomplish the required functionality will be fully developed, installed, tested and supported by the Contractor and Manufacturer. Provide proof of manufacturer certification for any new software provided.
5. Alarm Mode
 - a. One or more cameras may be associated with a controlled door or gate, or alarm monitored portal or area.
 - b. Associated cameras shall be programmed to be automatically pre-positioned and "called" into alarm mode by VSS event commands, to be displayed in full-screen view on a video workstation and recorded in "alarm/event mode".
 - c. The system shall allow an individual alarm input to initiate pre-positioning, viewing and recording sequences of two or more alarm point-associated cameras, simultaneously. When two or more cameras are simultaneously designated for event recording, they shall each be recorded in "alarm/event" mode.
6. Video Storage/Retrieval
 - a. Stored video will be time/date stamped and synchronized with the VSS clocks.
 - b. The system shall retrieve any stored video based on time/date parameters entered by the operator.
 - c. The system shall be capable of performing activity detection on stored video. Any recorded video channel may be selected and a zone may be selected within the view of the camera scene. The stored video can then be searched and will only display clips of video that identify motion in the selected zone.
7. Surveillance/Display Modes
 - a. Cameras may be used for assessment, to view areas of concern and provide video escort functions.
 - b. The system shall process video signals for primary display on video workstation display monitors. Video signals may be displayed in single or multi-view formats.
 - c. Selection of display formats shall be under the control of the operators, via their local video monitoring software, video control keyboards, or by computer-controlled graphical user interfaces.

- d. Display Modes: The system shall enable one or more cameras from any combination of areas or sites to be displayed on one or more video workstations or display devices, simultaneously.
 - 1) Single Camera Display: Any individual camera may be called-up and displayed on a video workstation, and by any other properly configured computer or LAN device, with VSS monitoring software.
 - 2) Multiple Display: Up to 16 cameras may be called-up and displayed simultaneously on each video monitor with VSS monitoring software. Cameras may be called-up for multiple display without regard to their location in the system, or on the network, such that each of the 16 cameras may be from 16 different sites or areas, displayed simultaneously on a video workstation.
- e. The system shall support independently configured display modes at each video workstation or LAN device, simultaneously. Display mode configured at one video monitoring device shall not affect the others.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Product Acceptability: The Products section contains lists of acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified. Considerations may include but shall not be limited to functional, physical, aesthetic and/or interface aspects. The Owner shall be the sole judge of whether or not a submitted substitution is deemed to be "equivalent" to that specified.

2.2 VIDEO SURVEILLANCE (VSS) EQUIPMENT

A. General

- 1. Network Video Recorder: Provide the number of NVR recorders necessary to manage and record video cameras at the project site, as shown on the drawings and as noted herein or directed by the Owner.
- 2. Software
 - a. Provide FLIR United VMS, IPDVMS software NVR component, to support the required monitoring, surveillance and recording capabilities and functionality, as specified. Ensure compatibility between the NVR application and the existing DVMS application.
 - b. Camera/Video Licenses: Provide additional number of camera licenses equal to the number of cameras shown on the drawings and added throughout the course of the project.
 - c. Client Workstations: Provide FLIR viewing software to support monitoring, surveillance, and review capabilities and functionality at the client workstations.
 - d. Provide Failover Directory licensing.
 - e. Provide Failover Channel licensing.

- f. Software support agreement (5) years.
- 3. Provide VSS Client Workstations where shown on the drawings and described herein.
- B. Network Video Recorder (NVR) Hardware Platform
 - 1. The recording platform shall be FLIR Latitude.
 - 2. FLIR Network Recorder License: Provide One per camera
 - 3. DDN Storage Fusion Architecture Appliance Parts:
 - a. Storage Base Unit
 - 1) SFA7990-FC16
 - b. SFA OS Licenses for each set of 20 drives in SFA7990
 - 1) LIC-SFA7990-OS20
 - c. Hard Drive 14TB
 - 1) H09C1400234NH27
 - d. Fiber Channel Card
 - 1) I-239-2NFC8
 - e. Expansion Storage Unit
 - 1) SS9012-SBOD
 - f. 12Gb/s HDmSAS to HDmSAS Copper Cable, 3m
 - 1) CBL-HMSHMS12C-3
- C. Directory Server
 - 1. (2) per site (1 per MDF)
 - 2. FLIR USS-ENT-00N0-00
- D. Archiver Server
 - 1. (2) per site (1 per MDF)
 - 2. FLIR USS-ENT-24R5-16
- E. Uninterruptable Power Supply (UPS)
 - 1. MDF(s)
 - a. APC SRT6KRMXLT-5KTF UPS
 - b. APC SRT192RMBP Battery
 - 1) Provide sufficient quantity of batteries to provide 4 hours of runtime.
 - c. APC AP9630 Network Card
 - 2. IDF(s)
 - a. APC SRT3000RMXLA UPS
 - b. APC AP9630 Network Card
- F. Power Distribution Unit (PDU) for MDF(s)
 - 1. APC AP8841
 - a. (1) per MDF

- G. KVM Monitor and Cables for MDF(s)
 - 1. Chatsworth 37203-161
 - a. (1) per MDF
- H. Workstations
 - 1. FLIR USS-WKS-QM2-HPS Workstation
 - 2. FLIR USS-MON-FHD 24" Monitor
 - a. Provide (2) monitors per workstation shown on plans.
- I. Video Cameras
 - 1. IP-Ready Cameras
 - a. All new cameras shall be IP-ready cameras, unless the conditions of installation or other special requirements dictate that an analog type camera must be used. Any such condition must be submitted for approval, and approved by the Owner, prior to installation.
 - 2. Mini-Dome Network Fixed Position Camera:
 - a. FLIR CM-3308-11-I
 - 3. Mini-Dome Network 180/360 degree Fixed Position Camera:
 - a. FLIR MC-6308-P1-I
 - 4. Mini-Dome Network PTZ Camera:
 - a. FLIR CP-6302-31-P & CP-POE-60W-US
 - 5. High Definition Corner IP Camera:
 - a. FLIR CC-3103
 - 6. Camera Integral Storage
 - a. (1) MicroSDXC 64GB per camera
 - b. Sandisk Ultra SDSQUNC-064G-AN6IA
- J. Camera Mounting Hardware
 - 1. Provision for mounting hardware: Contractor shall include provision and installation of miscellaneous hardware and mounting extensions at each camera location to provide acceptable viewing performance.
 - 2. Ancillary Hardware shall be provided by the Contractor, if required, and shall be compatible with and comparable in strength to other attached hardware.
 - 3. Provide wall mount, pendent mount, parapet mount, or ceiling mount as required by each location.
 - 4. Typical FLIR parts:
 - a. Pendant cap
 - 1) CM-CAPX-31
 - b. Short wall mount arm
 - 1) CM-ARMX-G3
 - c. Pole mount adapter
 - 1) CX-POLE-G3
 - d. Corner mount adapter

1) CX-CRNR-G3

K. Camera Power Supply (CPS)

1. POE Cameras: Cameras with direct IP compatibility shall be compatible with Power over Ethernet (POE+) standards, and will utilize POE/POE+ power from Contractor supplied Cisco network switches.

L. Wiring

1. General: Cables that are not installed in conduit shall be rated for plenum use.
2. Video:
 - a. IP Cameras, Interior or Protected Wiring: For cameras 100 meters or less from the applicable network switch, provide Category 6 (CAT6) cable. See division 27 for category cable requirements.
3. Exposed Camera Wiring: Wiring between camera enclosures and their respective 'J' Box shall be in "Sealtite" flexible conduit. Sealtite shall be firmly affixed to 'J' Box cover plate and camera enclosure. Refer to camera details.
4. Other cable and cable/interface combinations must be pre-approved by both the manufacturer and the Owner, prior to installation.

2.3 AUDIO CONNECTION

- A. Separate microphones shall be connected to an audio interface adapter with output to the camera audio input.

B. Audio Interface Adapter

1. Louroe Model IF-2, IF-4 or IF-8
 - a. Size according to inputs shown on plans.

C. Microphone

1. Louroe Model Verifact D-V.

D. Wiring

1. General: Cables that are not installed in conduit shall be rated for plenum use.
2. Audio:
 - a. Microphone Wiring: Provide West Penn 452, 22/2 AWG shielded miniature audio cable.

PART 3 - EXECUTION

3.1 GENERAL

- A. In accordance with Section 28 05 00, Security System General Requirements.

3.2 SYSTEM CONFIGURATION

- A. Camera recording and display configurations shall be arranged via a combination of the Video Server, Network Video Recorders, Video Monitoring Workstations, and LAN/Wireless LAN network.
- B. Contractor shall coordinate with the Owner to determine the required pre-programmed surveillance and event-initiated configurations.
- C. Audio connection: Microphones shown on plans shall be connected to the audio interface adapter input. Output from the audio interface adapter shall be connected to the audio line in interface on the camera nearest the microphone. Provide RCA to terminal block adapters as necessary.

3.3 SECURITY SYSTEM INTEGRATION

- A. Provide Access Control system integration equipment, software and programming, in accordance with Section 28 05 00, Security System General Requirements.

3.4 EQUIPMENT, RACK, AND CONSOLE INSTALLATION

- A. In accordance with Section 28 05 00, Security System General Requirements.

3.5 GROUNDING PROCEDURES

- A. Provide grounding of all systems and equipment in accordance with Section 28 05 00, Security System General Requirements.

3.6 WIRE AND CABLE INSTALLATION PRACTICES

- A. Provide wire and cable installation in accordance with Section 28 05 00, Security System General Requirements.

3.7 DATABASE PREPARATION, CHECKING, AND ACTIVATION

- A. Provide database preparation, checking and activation for systems and equipment in accordance with Security System General Requirements, Section 28 05 00.

3.8 START-UP RESPONSIBILITY

- A. Provide start-up services for all systems and equipment in accordance with Security System General Requirements, Section 28 05 00.

3.9 PRELIMINARY INSPECTION AND TESTING

- A. Provide preliminary inspection and testing services for systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.

3.10 SYSTEM PERFORMANCE TESTING AND ADJUSTING PROCEDURES

- A. Provide performance testing, burn-in, and adjusting of systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.
- B. VSS Performance Testing
 1. Demonstrate acceptable picture quality and camera views on each camera.
 2. Demonstrate acceptable picture quality on each video monitoring workstation, and display devices accessible over the Wireless LAN.
 3. Demonstrate no negative effects on of video image is observed while Pan-Tilt-Zoom cameras are being repositioned.
 4. Demonstrate switching, recording and playback functions for the video server, and digital video recorders.
 5. Demonstrate camera positioning functionality, on pan/tilt/zoom cameras, throughout the entire range of possible camera positions.
 6. Ensure primary views are acceptable. Demonstrate the view obtained by each pre-programmed camera position.
 7. Demonstrate automatic event-initiated recording sequences, including camera pre-positioning, where applicable.

3.11 BURN-IN PERFORMANCE PERIOD

- A. Provide a burn-in performance period to demonstrate the stability of the system, in accordance with Testing and Commissioning, Section 28 08 00.

3.12 COMMISSIONING AND VALIDATION

- A. Provide commissioning and validation services to prove and improve the effectiveness of the system, in accordance with Testing and Commissioning, Section 28 08 00.
- B. Coordinate with the Owner for the provision of these services.

3.13 FINAL PROCEDURES

- A. Perform final procedures in accordance with Section 28 05 00, Access Control General Requirements.

END OF SECTION

SECTION 32 1216

ASPHALT PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Paving for playground, parking areas, areas between buildings, synthetic track surfacing adjacent to planting and turf areas as indicated.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 31 2200 - Grading.
3. Section 32 0117 - Pavement Repair.
4. Section 31 2326 - Base Course.
5. Section 32 1236 - Seal for Bituminous Surfacing.
6. Section 32 1313 - Site Concrete Work.

1.02 SUBMITTALS

- A. Shop Drawings: Submit site plan indicating extent of paving and accessories.
- B. Product Data: Manufacturer's technical data for materials and products.

1.03 QUALITY ASSURANCE

- A. Comply with the following as a minimum requirement: Standard Specifications for Public Works Construction.

1.04 PROJECT CONDITIONS

- A. Information on Drawings or in soils report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.
- B. A copy of the soils report is available for examination in the office of the Architect during regular office hours of the Architect.

PART 2 - PRODUCTS

2.01 BITUMINOUS MATERIALS

- A. Provide materials of the class, grade, or type indicated on the Drawings, conforming to relevant provisions of Section 203 - Bituminous Materials of the Standard Specifications for Public Works Construction.

2.02 HEADERS

- A. Concrete: Per specification Section 32 1313 - Site Concrete Work.
- B. Wood:
 - 1. Redwood, Construction Heart Grade, size 2 by 6, unless otherwise indicated.
 - 2. Stakes: 2 by 4 redwood or 2 by 3 Douglas fir, Construction Grade.
 - 3. Nails: Common, galvanized, 12d minimum.

PART 3 - EXECUTION

3.01 HEADERS

- A. Install headers along edge of bituminous surfacing abutting turf, earth, or planting area, unless indicated otherwise.
- B. Install headers so the bottom surface has continuous bearing on solid grade. Where excavation for headers is undercut, thoroughly tamp soil under the header. Compact backfill on both sides of header to the density of adjacent undisturbed earth.
- C. Where wood headers are indicated on drawing, fasten headers in place with redwood or Douglas fir stakes of length necessary to extend into solid grade a minimum of 12 inches. Stakes shall be of sound material, neatly pointed, driven vertically, and securely nailed to headers. Space stakes, not to exceed 4 feet on center with top of stakes set one inch below top of header. Provide a minimum of two 12d galvanized common nails through each stake.
- D. Remove existing headers where new surfacing is installed adjacent to existing surfacing.
- E. Install temporary headers at transverse joints of paving where continuous paving operations are not maintained.
- F. Provide additional stakes and anchorage as required to fasten headers in place.

3.02 CONSTRUCTION OF ASPHALT CONCRETE PAVEMENT

- A. Thickness of Surfacing: Unless otherwise indicated on Drawings or specified, install bituminous surfacing to a compacted thickness of 2 inches.
- B. Provide surfacing material over base course as specified in Section 31 2326 - Base Course.
- C. Surfaces of walls, concrete, masonry, or existing bituminous surfacing indicated to be in direct contact with installed bituminous surfacing shall be cleaned, dried and uniformly coated with an asphaltic emulsion film.
- D. Thicken edges of bituminous surfacing that do not abut walls, concrete, or masonry, and edges joining existing bituminous surfaces. Remove headers at existing bituminous surfacing where new bituminous surfacing is to be installed. Thicken edges an additional 2 inches and taper to the indicated or specified thickness 6 inches back from such edges.
- E. At stairways, adjust thickness of paving such that the first tread is equal in height to all other treads.
- F. Provide adequate protection for concrete, planting areas, and other finish Work adjacent to areas indicated to receive bituminous surfacing.
- G. Placing:
 - 1. Do not install bituminous surfacing when atmospheric temperature is below 40 degrees F; or when fog or other unsuitable weather conditions are present. Temperature of mixture at time of installation shall not be lower than 260 degrees F in warm weather or higher than 320 degrees F in cold weather.
 - 2. Where 2-inch or 3-inch thick surfacing is indicated or specified, install surfacing in one course. Where surfacing is indicated or specified 4 inches or more in thickness, except for thickened edges, install bituminous surfacing in courses of approximately equal thickness, each course not exceeding 2 ½ inches in thickness.
- H. Stakes or Screeds: Provide grade or screed stakes spaced not more than 15 feet apart in flow lines with grades of less than one percent. Continuous screeds may be provided instead of stakes.
- I. Spreading: Install bituminous surfacing in a manner to cause least possible handling of mixture. In open areas and wherever practicable, install by mechanical means with a self-propelled mechanical spreader. In confined or restricted areas, install mixture with hot shovels and rakes, and smooth with lutes.
- J. Joints: Provide vertical joints between successive runs. Install joints true to line, grade, and cross section. Lapped joints are not permitted.
- K. Rolling:
 - 1. Finish roll with a self-propelled tandem roller weighing at least 8 tons. Break down roll with a self-propelled roller weighing between 1 ½ tons and 8 tons.

2. Roll in a manner that preserves flow lines and the established finished grades. Break down roll in areas adjacent to flow lines parallel to flow lines. Break down roll after bituminous surfacing is installed without shoving or cracking of mixture under roller. Continue finish rolling until surfacing is unyielding, true to grade, and meets requirements for specified smoothness. Areas inaccessible to finish roller may be finish rolled with breakdown roller or tamped with hot tamping irons and smoothed with hot smoothing irons or hand roller.
3. Where bituminous surfacing abuts concrete, masonry, walks or paving, tamp joint smooth, if necessary, as described above to obtain a uniformly even joint, true to line and grade. Tamp and smooth to properly compact.
4. Compacted bituminous surfacing shall be provided with a bulk specific gravity of at least 2.31 when tested in accordance with ASTM D1188.

3.03 TOLERANCE

- A. Smoothness: Surface of bituminous surfacing after rolling, shall be even, smooth and uniform in texture with no voids or rock pockets, free of roller marks or other irregularities, and not varying by more than 0.03 foot, except at local depressions or raised areas as indicated, when a 10-foot straightedge is placed on surface.
- B. Grade: Finished grade shall not vary more than 0.02 foot above or below required grade. Variations within prescribed tolerance shall be compensating so that average grade and cross-section are provided.
- C. Premium paving tolerances and requirements for synthetic track:
 1. General: Test in-place asphalt concrete courses for compliance with requirements or thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by Owner's representative.
 2. Thickness: Tolerances for thickness shall be 1/4 inch, plus or minus.
 3. Planarity: The asphalt substrate shall not vary from the planned cross slope by more than plus or minus 0.1 percent. The finished asphalt shall not vary, plus or minus, under a 10 feet straight edge greater than 1/8 inch. Flood test the surface with the use of a water truck. If, after 30 minutes on a 70 degree F day, "bird baths" are evident at a depth more than 1/8 inch repair using the best method of correction.

3.04 TESTING

- A. After first coat of surface seal has been installed and after a 24 hour period, the flood test shall be completed of the bituminous surfacing in presence of the Project Inspector. Repair areas of standing water or puddles and flood test locally; install surface seal and retest as necessary.

3.05 SURFACE SEALING

- A. After bituminous surfacing has passed flood test, clear and allow to dry and provide one more coat of surface seal as specified in Section 32 1236 - Seal for Bituminous Surfacing.
- B. Where indicated, provide multiple coats of surface seal to existing bituminous surfacing.
- C. Where new bituminous surfacing joins existing bituminous surfacing, overlap surface seal a minimum of 12 inches onto existing bituminous surfacing.

3.06 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

3.07 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 32 9000

PLANTING

PART 1 – GENERAL

1.01 SUMMARY

- A. Provide labor, material, equipment, and appliances necessary to provide trees, plants, and ground cover as indicated on Drawings, specified, and as required for a complete installation.
- B. Related Requirements:
 - 1. Division 01 - General Requirements.

1.02 SUBMITTALS

- A. Comply with provisions of Section 01 3300.
- B. Submit complete lists of landscape materials and equipment to be used, including manufacturers name and address, specific trade names, catalog numbers complete with illustrations and descriptive literature and clearly mark or underline proposed items; list sources of landscape topsoil.
- C. Provide plant material list.
- E. Certification: In addition to other required certification, furnish a certificate with each delivery of bulk material, including topsoil, planter mix soil, bark mulch, stating its source, quantity, type of material furnished and that such item or material conforms to requirements of this section.
- G. Sod: Furnish certificate by grower for type, and trueness to name of grass variety or strain.

1.03 QUALITY ASSURANCE

- A. Workers: Furnish skilled workers thoroughly trained and experienced in required crafts and familiar with specified requirements for proper performance of Work of this section.
- B. Codes and Regulations: Materials, fabrication, and installation in this section shall comply with applicable State Codes and Regulations. Deliver permits and testing certifications to Project Inspector.
- C. Quality and Size: Comply with current edition of "Horticultural Standards" for number one nursery stock as adopted by "American Association of Nurserymen".
- D. Plants:

1. True to name, with name of plants in accordance with standards of practice of "American Association of Nurserymen."
2. Botanical names take precedence over common names.

1.04 GENERAL REQUIREMENTS

- A. Contractor will verify that irrigation systems are operating before starting Work of this section.
- B. Existing Utilities and Plant Materials:
 1. Protect utilities and plant materials from damage.
 - a. Perform modifications only as permitted by Architect, in accordance with applicable provisions noted or specified on Drawings, or in other sections of these Specifications.
 2. Replace damaged plant material with like type and size material. Architect shall determine cost of irreplaceable plant material according to "square inch" method as described by Council of Tree and Landscape Appraisers' "Manual for Plant Appraisers" handbook, Current Edition, and "Guide for Establishing Values of Trees and Other Plants".
- D. Pest Management Method and Products:
 1. Contractor shall ensure that plants provided are clean, healthy, free of physical damage, and show no symptoms of abiotic injury. Plants must also be free of diseases, arthropod pests, and any other type of plant pests. Before applying pesticides to plants on County property, the following criteria must be met:
 - a. Individuals who apply pesticides on behalf of contractor's company must have a Qualified Applicator License in appropriate category of pest control issued by California Department of Pesticide Regulation and registered to conduct pest control for hire as a business by Los Angeles County Agricultural Commissioner's Office.
 - b. Length of time from date of use of a pesticide products until beneficial occupancy by Owner may not be less than five half lives of products used.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Plants shall be protected in transit and after delivery to Project site. Plants in broken containers and plants with broken branches or injured trunks will be deemed defective Work.
- B. Plant materials damaged in planting operations shall be replaced.

1.06 WARRANTY

- A. Shrubs and groundcover shall be growth and health guaranteed by installer for a period of 90 days after completion of maintenance period. Trees shall be installer guaranteed to live and grow in upright position for a period of one year after completion of maintenance period.
- B. Within 15 days after notification by Owner, remove and replace failed plantings. Replacement plantings shall be guaranteed as specified for original plantings.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Topsoil: Designated as imported topsoil as specified herein. Soil test will determine suitability of topsoil before installation. Transport topsoil from source to its final position unless stockpiling is specified.
 - 1. Imported Soil:
 - a. Shall be from a source outside Project site and in compliance with this section.
 - b. Imported topsoil shall be of a uniform composition and structure, fertile and friable sandy loam soil, and be free of roots, decay, subsoil, clods and stones larger than ¼ inch in greatest dimension, pockets of coarse sand, noxious weeds, sticks, brush and other litter and not be infested with nematodes or other undesirable insects and plant disease organisms. Imported topsoil shall meet following additional requirements:
 - 1) Gradation Limits: Sand – 50 to 80 percent, clay – 20 percent maximum, and silt – 30 percent maximum. Sand, clay and silt gradation limits shall be as defined in ASTM D422.
 - 2) Agricultural Suitability and Fertility: Topsoil shall be fertile and friable garden soil suitable for sustaining and promoting growth of specified plants.
 - 3) Electrical conductivity less than 2.0 milliohms/centimeter or DS/m.
 - 4) Boron content maximum of 1.0 part per million.
- B. Fertilizers and Conditioning Materials: Comply with applicable requirements of State of California Agricultural Code:
 - 1 General:
 - a. Fertilizing materials shall be packaged, first grade, commercial quality products identified as to source, type of material, weight and manufacturer's guaranteed analysis.

- b. Fertilizing material shall not contain toxic ingredients and fillers in quantities harmful to animal, human or plant life.

2. Materials:

- a. Bone Meal: Commercial raw bone meal shall be finely ground, steamed dry material with a minimum analysis of 2.5 percent nitrogen and 22 percent phosphoric acid.
- b. Gypsum: Hydrated calcium sulfate produce containing 23 percent calcium and 18 percent sulfur with a guarantee analysis of 84 percent calcium sulfate.
- c. Soil Sulfur: Guarantee analysis of 99 percent sulfur.
- d. Superphosphates: First grade finely ground phosphate rock used for agricultural purpose, containing minimum 18 percent phosphoric acid by volume.
- e. Commercial Fertilizer: Pellets or granular product having a chemical analysis of 14-14-14, with a minimum of 68 percent of nitrogen from slow release nitrogen unless otherwise specified in Soil Analysis Report: it should be a free flowing material delivered in unopened bags, do not install material which becomes caked or otherwise damaged.
- f. Nitrogen Fortified Wood Product: Derived from redwood, fir or cedar sawdust or from bark of fir or pine treated with a non-toxic agent to quickly absorb water and comply with following requirements:

1). Gradation:

SIEVE SIZE	PERCENT PASSING
¼-inch	95 percent minimum
#8	80 percent minimum
#35	30 percent minimum

Nitrogen Content:

NITROGEN CONTENT	PERCENT DRY WEIGHT
Redwood	0.4 to 0.6 percent
Fir	0.56 to 0.84 percent
Cedar	0.56 to 0.84 percent
Fir Bark	0.8 to 1.2 percent
Pine Bark	0.8 to 1.2 percent

- 3) Salinity: Maximum saturation extract conductivity 2.5 milliohms/centimeter at 25 degrees Celsius.

4) Absorption: When one teaspoon of water is applied to 4 cubic inches of air-dried products, material shall become completely damp in a period of less than 2 minutes. Kellogg KRA, Sequoia Redwood/Cedar Blend or White Fir, Long Beach Soil Preparation, Bandini #101 Redwood Soil Builder or nitrogenized wood amendment.

g. Organic Fertilizer: Treated, relatively dry friable organic compost derived from sewage sludge processed for agricultural use; containing at least 1 percent nitrogen by dry weight, 2 percent phosphoric acid and comply substantially with gradation noted in sub-section 2.1, B6. Milorganic, Kellogg's Nitrohumus, or equal.

C. Prepared Backfill mix:

1. To be based upon recommendations from soils test performed by a certified laboratory.
2. Mix (for bidding purposes):
 - a. Seventy percent by volume clean excavated topsoil/import soil.
 - b. Thirty percent by volume nitrogen stabilizer wood residual.
 - c. One pound per cubic yard gypsum.
 - d. Two pounds fertilizer per cubic yard (14-14-14 with a minimum 68 percent of nitrogen from slow release nitrogen. Additional secondary and micronutrients preferred).
3. Mix (acid plants)
 - a. Thirty percent by volume clean excavated soil/imported soil.
 - b. Seventy percent by volume nitrogen stabilized wood residual.
 - c. Two pounds .per cubic yard. soil sulfur.
 - d. Two pounds. fertilizer per cubic yard (14-14-14 with a minimum 68 percent of nitrogen from slow release nitrogen. Additional secondary and micronutrients preferred).

D. Plants (General): Plant names indicated or listed on Drawings shall conform with Sunset, Western Garden Book, latest edition.

1. Type and Size: Plant materials shall be listed on Drawings.
2. Plants shall be true name, and one of each bundle or lot shall be tagged with Botanical/Common name and size of each plant in accordance with standards of practice recommended by American Association of Nurseryman

3. Tag one plant of each variety for identifying purposes.
4. Plantings shall be inspected before installation.
5. Substitutions: When plants of a specified kind or size are not available, substitution may be requested in accordance with General Conditions.
6. Plants shall have a growth habit normal to species in accordance with USA Standards for Nursery Stock, latest editions; shall be sound, healthy, vigorous, and free from insect pests, plant disease, sun scalds, fresh bark abrasions, excessive abrasions or other objectionable disfigurements. Tree trunks shall have normal well developed branch systems and vigorous and fibrous root systems, not root bound and shall be free of kinked or girdling roots.
7. Plantings specified for adverse conditions shall be Project site acclimated before planting. Purchase from local nurseries or store on Site for a period of 10 weeks for autumn planting and six weeks for spring planting.

E. Plant Material:

1. Trees: Trees shall conform to type and size noted on Drawings. Measure height from root crown to last division of terminal leader and measure diameter 1 ft. above root crown. Measure height of palm trees from ground line to base of growing bud. Palms shall stand reasonably erect without support.
2. Shrubs: Specified type and size selected from high quality well shaped nursery stock.
3. Flatted Plants: Grown and remain in flat until transplanted at Project site. Soil and spacing of plants in flat shall insure minimum disturbance of root system at time of transplanting. Maximum plants per flat to be 64 to 100 plants, or as indicated in Drawings.
4. Sod: Mixture of specified proportions of well established sod grass, vigorous well rooted healthy sod, free from disease, insect pests, weeds, other grasses, stones, and other harmful or deleterious matter.
5. Grass Seed: First quality from a new crop seed.
6. Use non-hulled seed except during months of May through September. During remaining months provide hulled seed.

F. General Materials:

1. Pipe: Galvanized steel, standard weight (schedule 40) complying with ASTM A120.
2. Nails, fasteners, etc.: Galvanized and commercial quality materials.
3. Fabricated metal items: Steel conforming to ASTM A36.

4. Concrete items: Standard 2000 psi concrete.
- I. Concrete headers: 6-inch by 8-inch size, complete with pre-molded expansion joint material 10 ft. apart or as indicated on Drawings.
- J. Composite Headers: Headers and stakes shall be composite material sizes as indicated on Drawings. Screws shall be plated deck screws. Stakes shall be 1 inch by 2-inch by 12-inch in length and headers shall be furnished in 2-inch by 4-inch by 20-foot in length and shall be of uniform width and thickness.
- K. Tree Stakes: Steel stakes shall be the R2 Stake System (also known as the Reddy Stake System) manufactured by J. R. Partners or equal. Provide two R2 Stakes per tree. Use 7 feet R2 Stake for 15 gallon size trees and smaller and the 9 feet R2 Stake for 24-inch box size trees or smaller. Use the Mega Stake for 36 inches and 48 inches box size trees. If trees are surrounded by steel grates, utilize the Grate Stake for 24-inch box size trees and smaller and the Mega Grate Stake for 36-inch box size trees or smaller.
- L. Tree Ties:
 1. Wire Type: No. 10 gage BMG galvanized soft steel wire covered with garden hose.
 2. Cinch Tie: Flexible vinyl with adjustable interlocking capability.
- M. Tree-Root Control Barrier: Shall be fabricated from a high density and high impact plastic such as polyvinyl chloride, ABS or polyethylene, and have a minimum thickness of 0.06 inch. Plastic shall be furnished with ½ inch to ¾ inch high raised vertical ribs on inner surface spaced at least 6 inches but not more than 8 inches apart. Install a plastic root control barrier with each new tree planted within a tree well. Deep Root Corp., or equal.
- N. Pest Management Methods and Products: Refer to paragraph 1.04.F for details pertaining to Contractor applying pesticides.
- O. Jute matting shall be of a uniform open plain weave, single jute yarn, not varying in thickness by more than one half its normal diameter. Jute matting shall be furnished in rolled strips as follows: Length, approximately 50 to 75 yards, width, 45 inches to 50 inches. Ludlow Soil Saver No. 48, or equal.

PART 3 – EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine areas and conditions under which Work of this Section will be performed. Correct detrimental conditions before commencing Work of this section.

3.02 GRADING AND SOIL PREPARATION

- A. Earthwork and Topsoil Placement: Shall include excavation and backfilling for irrigation system and preparation for spreading, densification, cultivation, and raking of topsoil, including fertilization and conditioning.
- C. Preliminary Grading: Scarify existing soil to a depth of 6 inches before backfilling with topsoil. During preliminary grading operation, remove stones over $\frac{3}{4}$ inch.
- D. Topsoil Preparation and Conditioning:
 - 1. Type and Thickness: Topsoil shall have a minimum depth of 6 inches above subgrade or as indicated on Drawings, whichever is greater.
 - 2. Before installing topsoil, subgrade shall be cleared of weeds, rock $\frac{3}{4}$ inch and larger and other extraneous materials from designated planting areas to a depth of 6 inches. The tools acceptable for this cleaning process are a Rock Picker by Harley Enterprise, Track Screener by Cherrington, Screen USA Inc. or other tools or machines designed for the purpose. The finished planting bed preparation is subject to the approval of the Owner's representative.
 - 3. Do not process topsoil when it is so wet or dry as to cause excessive compaction or forming of hard clods or dust.
- F. Fertilizing and Conditioning: Provide planting areas to finish grades, including mounds, before installation of specified fertilizer or soil conditioning materials.
 - 1. Mechanically install following amount of fertilizer or soil conditioning materials at a uniform rate per 1,000 square feet of planting area:
 - a. Three cubic yards of nitrogen fortified wood compost.
 - b. Two cubic yards of organic fertilizer.
 - c. One hundred pounds. of gypsum.
 - d. Thirty pounds of commercial fertilizer.
 - 2. Quantities of required materials for planting areas shall be at Project site. Furnish Project Inspector with delivery tickets before installation to verify source, kind, and quantities delivered.
 - 3. After installation of fertilizer and soil conditioning materials, uniformly cultivate materials into upper 6 inches of soil with suitable equipment operated in at least two directions at approximate at right angles. Process soil until friable.
- G. Finish Grading:

1. Provide a finish grade, smooth, uniform, and free of abrupt grade changes and depressions to insure proper surface drainage.
 2. Finish grades adjacent to paving curbs or headers shall be 1 inch lower in sod areas and 2 inches lower in shrub or ground cover areas.
 3. Irrigate soil after installation of fertilizer and soil conditioning materials. Allow soil to settle. Provide a stable surface. After soil has dried out to a workable condition, re-grade, rake, and smooth to required grades and contours. Finished surfaces to be left clean and suitable for planting.
 4. Areas to be planted shall be graded and floated to provide complete surface drainage; water holding depressions and pockets shall be eliminated. Undulations and unsightly variations in grade which will not permit the use of normal mowing equipment without scalping or missing shall be removed so that proper use of mowing equipment can be performed.
 5. Areas to be planted shall also be finished graded to meet any walks, paths or other adjoining surfaces so that, after compaction, no water pockets or ridges remain.
 6. Areas where sod will interface with other modes of planting at catch basins and paved areas shall be finish shaped so as to counter sink the sod one inch such that once sod is placed, it shall be at grade with adjacent planting bed.
- H. Trenching: After completion of soil conditioning or finish grading operations, backfill upper portion of trench so specified topsoil thickness in trench is restored.
- J. Weeding: Once site has been cleared, grubbed and rough graded, landscape areas shall be maintained free of vegetation growth until start of irrigation and planting phase of work.

3.03 PLANTING

- A. General: Planting materials shall be inspected before planting, including those tagged at nursery.
1. Perform planting with material, equipment and according to procedures favorable to optimum growth of plant. Do not plant during windy conditions.
 2. Except as noted for specimen planting in sub-section 3.04D, commence planting operations immediately following completion of irrigation system.
- B. Protection and Storage:
1. Maintain plantings delivered to Project site in a healthy condition.
 2. Do not allow plantings to dry out.

3. Separate bare root stock and "heal in" in moist earth or other suitable material.
 4. Cover root ball of bailed or burlap wrapped plantings with moist sawdust, wood chips, or other permitted materials.
- C. Layout and Plant Locations:
1. Plant locations indicated on Drawings are approximate.
 2. Plants may be re-spotted before planting as required by Architect.
 3. Locate first row of plantings in areas designated for on center spacing at one-half the designated spacing from edge of area.
- D. Specimen Planting: Plantings in boxes 24 inches or larger shall be installed before installation of lateral irrigation lines. Re-route irrigation lines in conflict with specimen locations to clear root ball.
- E. Tree and Shrub Installation:
1. Excavate planting holes approximately square with vertical sides shall be twice the width of plant container or root ball; larger if necessary to permit handling and installation without damage to root ball system. Bottom of plant container or root ball shall be placed on existing undisturbed soil.
 2. Do not install plantings having a broken or cracked root ball.
 3. Containers should be opened and removed in such a manner not to damage root system.
 4. Remove balled plant wrappings after plant is positioned in hole.
 5. Scarify native soil at bottom half of holes to a depth of 6 inches.
 6. Backfill bottom half of hole with specified backfill mix minus fertilizers. Settle with water.
 7. After water settling bottom half of hole, set planting approximately in center of hole and adjust root flush to finish grade.
 8. Backfill balance of hole with specified backfill mix and fertilizer and water settle.
 9. Prune or remove any broken or damaged limbs.
 10. Form a circular watering basin slightly larger than hole; 4-inch high for trees and 2-inch high for shrubs. Shape bottom of basin to be slightly lower than finish grade.
 11. Restore area around plantings to finish grade.

12. After installation, plantings shall be plumb with root crown at its natural depth with respect to finish grade.
 13. New trees in sod areas to be installed with tree trunk protector.
- F. Backfill Planting Mix: Consists of 70 percent specified topsoil, and 30 percent nitrogen fortified sawdust mulch plus the amendments indicated in soil analysis report.
- G. Ground Cover Planting:
1. Complete soil preparation and fine grading before installation of ground cover plantings.
 2. Install ground cover in moist soil, spaced as indicated on Drawings.
 3. Install each plant with its proportionate amount of flat soil to minimize root disturbance.
 4. The degree of soil moisture in flat shall be such that soil does not crumble when removing planting.
 5. Following installation of ground cover, restore finish grade to insure proper surface draining.
- I. Sod:
1. Complete fine grading and specified soil preparation before lawn installation.
 2. Apply starter fertilizer per supplier's recommendations.
 3. Sod or Roll Sod: type, thickness, and areas of installation shall be in accordance with Drawings and Specifications.
 4. Remove roll sod netting prior to installation.
 5. Thickness of sod or roll sod shall be recommended thickness below finish grade. Complete soil conditioning and fine grading before installation. Do not operate heavy equipment over completed sub-grade. Sub-grade shall be moist when sod is installed. Install sod with closely fitted joints and stagger ends of strips. Plug opening with sod or topsoil.
 6. Lightly irrigate within two hours after installing sod and before rolling. Roll seams and joints until sod is well bonded to sub-grade.
 7. Water area thoroughly to penetrate sub-grade at least 8 inches. Repeat watering as necessary to keep sod moist until rooted in sub-grade. Protect sod areas against foot traffic until sod is well established. Replace damaged areas with new sod.
 8. Sod installation shall be complete at least 12 weeks prior to the opening of school.

J. Repair of existing or newly installed sod area:

1. Rake, drag, float and roll seed bed as often as necessary to produce a true, uniform, and smooth seed bed. Remove debris, stones, etcetera.
2. Prior to any lawn installation, obtain approval on fine grading of bed for sod areas.
3. Water seed bed thoroughly until a moisture penetration of 8 inches is achieved.
4. Seed mixture shall be sown at following rates:
 - a. Common Bermuda: 4 pounds per 1000 square feet or as recommended by manufacturer.
5. Seeding by hand, "Cyclone" type seeder, or pushed seeder shall be done in two passes at right angles to each other using 50 percent of specified rate for each pass. After seeding, apply a top dressing of wood residuals at rate of $\frac{3}{4}$ cubic yards per 1,000 square feet.
6. Large sod areas shall be seeded by using "Brillion" type seeder. Areas inaccessible to seeder shall be handed seeded and seed raked lightly into top $\frac{1}{4}$ inch of seed bed.
7. Irrigate immediately after completion and irrigation as frequently as necessary to assure complete germination of seed without creating run-off.
8. Areas that do not germinate satisfactorily shall be reseeded at proper intervals until an overall acceptable stand of grass is produced. Good turf coverage will be required before final acceptance of work.
9. Protect new sod from damage by erosion, trespass or any source. Safeguards and temporary fencing shall be erected where necessary, and precautions taken to prevent excessive runoff.

K. Hydro-Seeding (Supplement of Sod Area):

1. Mix slurry of seeds and fertilizer to produce a homogeneous slurry mixture in designated proportions. Discharge system shall apply slurry at a continuous and uniform rate.
2. Immediately after application, irrigate seeded areas thoroughly. Application pattern shall conform to irrigation system so that watering can be accomplished in a timely sequence.
3. Program watering so that repeated watering at short application times can be made to prevent excessive runoff and to prevent erosion.

4. Prior to planting, hydro-seeding shall be done. Abutting ground cover beds shall be neatly trimmed to forms and lines shown on drawing.
5. Areas that do not germinate satisfactorily shall be reseeded at 14-day intervals until an overall acceptable stand of vegetation is achieved.

L. Hydroseed slurry: Proportions to be as follows:

	Manufacturers
Seed mix (see paragraph 2.01)	Recommendation
Wood Cellulose fiber (dyed green)	2000 pounds per acre
M-Binder Soil Stabilizer	100 pounds per acre
Triple Super Phosphate	250 pounds per acre
Water and Dye	As needed

M. Transplanting of Existing Plant Material: In accordance with current horticulture practices.

1. Box or root system as necessary to maintain plant materials in a healthy, growing condition.
2. Equivalent size and kind of plantings may be provided instead of transplanting an existing planting.

N. Fertilizing: At 30 day intervals after sod or ground cover installation, install an all purpose 15-15-15 commercial fertilizer at rate of 10 pounds per 1,000 square feet of installed area. Thoroughly water area after applying fertilizer. Fertilizer applications shall be performed under observation of Project Inspector.

3.04 MAINTENANCE AND PLANT ESTABLISHMENT

- A. Required: Maintain areas on a continuous basis as they are completed during progress of Work and during establishment period. Maintenance shall include continuous operations of watering, weeding, trimming, rodent control, reseeding, planting replacement irrespective of cause or any other operations necessary to assure normal plant growth.
- B. Keep planting areas free of debris and weeds. Cultivate at intervals not to exceed 10 days.
- C. Sod Maintenance:
 1. Perform first mowing of sod areas when grass is 2 1/2 inches high and repeat as often as is necessary to maintain sod at a height of 2 inches. In no case shall sod be cut lower than 1 1/2 inches in height unless otherwise indicated.
 2. After each cutting, edge of grass shall be trimmed to a neat and uniform line.
 3. Grass clippings shall be removed and legally disposed of off Project site.

- D. Pruning: Required pruning of plants at start of plant establishment period shall be as required by Architect.
- E. Plant Establishment Inspection:
 - 1. Request an inspection to begin plant establishment period after plantings and related Work has been completed in accordance with Contract Documents.
 - 2. Upon successful completion of inspection, effective commencement date of plant establishment period shall begin.
 - 3. Plant establishment period for shrubs and ground cover, shall be 90 calendar days and for trees shall be one year or as otherwise indicated in Contract Documents.
 - 4. Architect may recommend extension of plant establishment period if planting areas are improperly maintained, appreciable plant replacement is required, or other defective Work.
- F. Damage:
 - 1. Immediately replace failed or damaged plantings.
 - 2. Provide replacement plantings of same type and size to match adjacent plantings. Furnish plantings and fertilizer as specified. New plantings shall be subject to a 30 day establishment period.
 - 3. Damage to planting areas shall be repaired immediately. Depressions caused by vehicles or foot traffic shall be filled with topsoil and leveled.

3.05 CLEANUP

- A. Remove rubbish, debris and waste materials and legally dispose of off Project site.

END OF SECTION