Andrew W. Breidenbach
Environmental Research Center (AWBERC)
Cooling Tower Replacement
Cincinnati, Ohio

Final Submission

August 16, 2004

Project Manual

Project: Cooling Tower Replacement

Owner
Environmental Protection Agency
26 West Martin Luther King Drive
Cincinnati, Ohio 45268

Architects and Engineers
Cannon Design
1100 Wilson Boulevard, Suite 2900
Arlington, VA 22209

Code Compliance
This Project is in conformance with the International Building Code, the Model Code published in 2000.

Asbestos Certification
No asbestos-containing building materials (ACBM) are used in new construction. Work includes remediation of asbestos-containing material as described herein and may involve unknown or suspected asbestos-containing materials (ACBM).

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REPORT OF LIMITED ASBESTOS-CONTAINING MATERIAL SURVEY

1. Asbestos-related investigations have been made and the results are bound herein immediately following this page.

2. These investigations are for examination by bidders but are not a part of the Contract Documents.

3. Bidder is responsible for any conclusions drawn from asbestos investigation data. If Bidder prefers not to assume such risk, Bidder is under obligation to employ its own experts to analyze available information. Bidder is responsible for any consequences of acting on conclusions obtained.

4. Owner does not guarantee continuity of conditions indicated at investigation locations.

REPORT OF
LIMITED ASBESTOS-CONTAINING
MATERIAL SURVEY

EPA AWBERC Cooling Towers

Cincinnati, Ohio

Prepared for:
Cannon Design
1100 Wilson Boulevard, Suite 2900
Arlington, Virginia 22209

Prepared by:
MACTEC Engineering and Consulting, Inc.
22455 Davis Drive, Suite 100
Sterling, Virginia 20164

July 15, 2004

MACTEC Project 3553-04-0409

July 15, 2004

Mr. Tony Ramis
Project Manager
Cannon Design
1100 Wilson Boulevard
Suite 2900
Arlington, Virginia 22209

Subject: Report of Limited Asbestos-Containing Material Survey
EPA AWBERC Cooling Towers
Cincinnati, Ohio
MACTEC Project 3553-04-0409

Dear Mr. Ramis:

MACTEC Engineering and Consulting, Inc. (MACTEC) is pleased to present this report of our limited asbestos-containing materials (ACM) sampling at EPA AWBERC Cooling Towers in Cincinnati, Ohio. Our services were provided at your request and based on your acceptance of MACTEC Proposal PROP04WASH-162, dated June 4, 2004. This report includes sections describing project information, scope of services, results and findings, and recommendations and conclusions. Also enclosed with this report are Appendix A – Asbestos Bulk Analytical Laboratory Reports and Appendix B – Asbestos Abatement Specifications.

Project Information

The EPA AWBERC cooling towers are located at 26 West Martin Luther King Drive in Cincinnati, Ohio. Renovations are currently planned to the cooling towers. The renovation activities are expected to impact existing suspect ACM. MACTEC was requested to provide limited ACM sampling services at the subject site to document the presence, location, and approximate quantities of these suspect ACM and prepare asbestos abatement specifications.

Limited Asbestos-Containing Material Survey

Initially, MACTEC representative Mr. Chris Kuettner, an Environmental Protection Agency (EPA) accredited asbestos inspector, conducted a walk through of the interior of the facility to observe the corrugated cementitious/cement board panels on the cooling towers prior to sampling. The asbestos survey was conducted in general accordance with EPA Standards 40 CFR 763, Subpart E, Asbestos Hazard Emergency Response Act (AHERA) and 40 CFR 61, Subpart M, National Emission Standards for hazardous Air Pollutants (NESHAP), and OSHA Standard 29 CFR 1926.1101 sampling protocol. Following a visual inspection of the project area for suspect asbestos-containing materials, MACTEC collected six bulk samples representing three homogeneous sampling areas that were suspected to contain asbestos. Homogeneous sampling areas are materials that are similar in texture, size, color, age, etc.

The collected bulk samples were submitted to the MACTEC asbestos analytical laboratory in Atlanta, Georgia for analysis by Polarized Light Microscopy/Dispersion Staining (PLM) in accordance with EPA Method - Determination of Asbestos in Bulk Building Materials (EPA 600/R-93/116). The MACTEC asbestos analytical laboratory is accredited by the National Institute of Standards and Technology, National Voluntary Laboratory Accreditation Program for bulk asbestos identification by PLM. The laboratory analytical reports are provided in Appendix A for your reference.

2.2 Asbestos Survey Findings and Results

The following suspect materials were observed and sampled within the project area during the inspection:

- Cementitious wall panels
- Cementitious cooling fins
- Collars on fan assembly

Based upon laboratory analysis, the following materials were reported as containing greater than one percent asbestos.

- Cementitious wall panels located on the north and south ends of the cooling towers – approximately 1,500 square feet; and
- Cementitious cooling fins located on the east and west sides of the cooling towers – approximately 5,000 square feet.

The remaining sample results were reported by the laboratory as “None Detected”.

2.3 Evaluations and Conclusions

The asbestos-containing cementitious panels are Category II non-friable materials as defined in the EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) Standard, 40 CFR 61, Subpart M. A non-friable asbestos-containing material is defined as any material that contains more than one percent asbestos by weight that hand pressure cannot crumble, pulverize, or reduce to powder when dry. The non-friable asbestos-containing materials were observed to be in generally good condition at the time of the survey.

The non-friable ACM should be properly removed by a qualified, State of Ohio licensed asbestos abatement contractor prior to being impacted by renovation or selective demolition activities in accordance with applicable EPA, OSHA, State of Ohio, and local regulations.

Suspect materials within inaccessible areas or in areas not observed by MACTEC can be considered as ACM or non-ACM based upon the analytical results of those materials that are homogeneous with those confirmed or sampled during the survey. Suspect materials that are not homogeneous with those confirmed or sampled by MACTEC must be assumed to be ACM until sampled and proven otherwise.

Closing

We appreciate the opportunity to work with Cannon Design on this important project. If you have any questions following your review of this report, please do not hesitate to call us.

Sincerely,

MACTEC ENGINEERING AND CONSULTING, INC.

Jennifer R. Medicus
Staff Scientist

Peter C. Frederick, CIAQP
Principal Scientist/Project Manager

Enclosures: Appendix A – Asbestos Bulk Analytical Laboratory Reports
Appendix B – Asbestos Abatement Specifications

APPENDIX A

Asbestos Bulk Analytical Laboratory Reports

PLM REPORT SUMMARY

Mactec Engineering and Consulting, Inc.
396 Plasters Ave. NE
Atlanta, GA 30324 (404) 873-4761

NVLAP Lab No. 101066
TDH License No. 30-0306

Client :	EPA-Cincinnati	Mactec Job No. :	3553-04-0409
Project :	EPA-Cincinnati	Report Date :	7/13/2004
Client Project No. :	N/A	Sample Date :	Not Provided
Identification :	Asbestos, Bulk Sample Analysis		
Test Method :	Polarized Light Microscopy / Dispersion Staining (PLM/DS) EPA Method 600/R-93/116		

On 7/12/2004, six (6) bulk material samples were submitted by Chris Kuettner for asbestos analysis by PLM/DS.

Lab Sample No.	Sample Description / Location	Asbestos Content
160983	Collar Mounting Assembly for Fans HA1-1	None Detected-Collar Material
160984	Collar Mounting Assembly for Fans HA1-2	None Detected-Collar Material
160985	Transite Panels Forming a Wall HA2-1	25% Chrysotile-Cement Board
160986	Transite Panels Forming a Wall HA2-2	25% Chrysotile-Cement Board
160987	Transite Cooling Fans HA3-1	30% Chrysotile-Cement Board
160988	Transite Cooling Fans HA3-2	30% Chrysotile-Cement Board

These samples were analyzed by layers. The first percentage is the overall asbestos content for the sample. Specific layer or component asbestos content is indicated wh relevant. The EPA considers a material to be asbestos containing only if it contains more than one percent asbestos by Calibrated Visual Area Estimation (CVAE). EPA regulations also state that Regulated Asbestos Containing Materials (RACM) -- materials which are friable or may become friable -- be further analyzed by point counting when the results indicate less than ten percent asbestos by CVAE. Our laboratory utilizes CVAE on a routine basis and does not include point counting unless specifically requested. These reports may not be reproduced except in full. Any unauthorized use or distribution of these reports shall be at the client's and recipient's sole risk and without liability to Mactec Engineering and Consulting, Inc.

PLM REPORT SUMMARY

Mactec Engineering and Consulting, Inc.
396 Plasters Ave. NE
Atlanta, GA 30324 (404) 873-4761

NVLAP Lab No. 101066
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Client :	EPA-Cincinnati	Mactec Job No. :	3553-04-0409
Project :	EPA-Cincinnati	Report Date :	7/13/2004
Client Project No.:	N/A	Sample Date :	Not Provided
Identification :	Asbestos, Bulk Sample Analysis		
Test Method :	Polarized Light Microscopy / Dispersion Staining (PLM/DS) EPA Method 600/R-93/116		

STATEMENT OF LABORATORY ACCREDITATION

These samples were analyzed at the Atlanta Branch of Mactec Engineering and Consulting, Inc. in the Asbestos Laboratory at 396 Plasters Ave. NE, Atlanta, GA, 30324. The laboratory holds accreditation from the National Institute of Standards and Technology (formerly National Bureau of Standards) under the National Voluntary Laboratory Accreditation Program (NVLAP). This laboratory also is licensed and authorized to perform as an Asbestos Laboratory in the State of Texas within the purview of Texas Civil Statutes, Article 4477-3a, as amended, so long as this license is not suspended or revoked and is renewed according to the rules adopted by the Texas Board of Health.

The samples were analyzed by polarized light microscopy in general accordance with the procedures described in the Method for the Determination of Asbestos in Bulk Building Materials, EPA/600/R-93/116. The results of each bulk sample analysis relate only to the material tested. This report shall not be used to claim product endorsement by NVLAP or any agency of the U.S. Government.

Specific questions concerning bulk sample results shall be directed to the PLM Laboratory Manager.

Analyst : Chris DuBour

PLM Laboratory Manager : Christopher DuBour

Approved Signatory : Chris DuBour

NVLAP

160983 - 160988

MACTEC

Bulk Sampling Record / Chain of Custody

Project Name: EPA - CINCINNATI	Project Number: 3553-04-0409
Client:	Facility Name: EPA Bldg
Sampler's Name: CHRIS KUETTNER	Subject Area: CHILLER TOWERS
Date Samples Collected: 7.9.04	Sampler's Signature: C. P. Kuettner

Sample Number	Material Type	Material Description	Sample Location	Condition	Lab ID
HA1-1	FIBROUS	~~[illegible]~~ WOOL	~~[illegible]~~ MOUNTING ASSEMBLY	NON-FRIABLE ~~INTACT~~	
HA1-2	"	"	FOR FANS		
HA2-1	"	TRANSITE	PANELS FORMING A WALL		
HA2-2	"	"	"		
HA3-1	"	"	COOLING FINS		
HA3-2	"	"	"		

Transmitted From:

MACTEC Engineering and Consulting
601 Washington Avenue • Suite 330 • Newport, Kentucky 41071
859.581.6031 • Fax: 859.581.6036

Sender's Signature: C. P. Kuettner

Transmitted To:

Quality Assurance Specialist – ATTN: David Toney
431 South Broadway, Ste. 122 – Lexington, KY 40508
859.254.1093

Recipient's Signature: [illegible]
07/12/04

APPENDIX B

Asbestos Abatement Specifications

See Spec Section 13281N

SECTION 01010 - SUMMARY OF WORK

1.1 RELATED DOCUMENTS:

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

B. The General Conditions of the Contract for Construction, Form A201, 1997 Edition, as prepared and published by the American Institute of Architects and all documents referenced therein, are hereby made a part of these specifications to the same extent as if written out in full and shall govern the performance of this contract. Government documents or requirements shall be followed as in force where conflicts exist with the General Conditions Form A201.

1.2 PROJECT DESCRIPTION:

A. The work of this Project consists of:

1. Replacement of existing cooling towers, pumps and associated equipment, piping and structures.
2. Addition of new chilled/ condenser water system controls with provision for future expansion into provision of new controls for the entire building
3. Provision of a water-side economizer.
4. Addition of underground domestic cold water piping.
5. Alterations to the cooling tower-related equipment.
6. Addition of a pre-engineered metal building pump house within the existing cooling tower basin.
7. Replacement of a high-voltage electrical feeder.
8. Provision of personnel doors to an existing interior multiple-duct shaft.
9. Demolition, site work, concrete and work of other trades related to the aforementioned are included in the work as indicated.

1.3 DRAWINGS INCLUDED IN CONTRACT DOCUMENTS:

A. Refer to List of Drawings Located on the Title Sheet of the Drawings.

1.4 CONTRACT:

A. Construct all the Work Under Single Lump-Sum Contract

1.5 WORK OF CONTRACTORS:

1.6 CONTRACTOR'S USE OF PREMISES:

A. Conform Operations at the Site to Areas and Methods Permitted by:

1. Laws.
2. Ordinances.
3. Permits.
4. Contract Documents.
5. Owner's regulations.

B. General: Limit use of the premises to construction activities in areas indicated; allow for Owner occupancy and use by the public.

C. Keep driveways and entrances serving the premises clear and available to the Owner and the Owner's employees at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.

D. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

E. Do not unreasonably encumber site with materials or equipment.

F. Do not load structure(s) with weight that will endanger structure.

G. Each Contractor/Subcontractor is responsible for protection and safekeeping of his materials, products and equipment stored on the premises or incorporated into the construction, until his contract is complete and accepted by the Owner.

H. Move at the Contractor's/Subcontractor's cost any stored materials, products or equipment which interfere with operations of Owner or others.

1. Use of Existing Elevators: The Contractor will be permitted to use freight elevator for freight service and transportation of construction personnel during the construction period. This elevator must also be available to the Owner at all times; coordinate usage with the Owner's representative. Provide protective pads for the cab and other appropriate protective measures for the car and entrance doors and frames. At the end of construction, restore the elevator to its original condition, replace worn cables, guide shoes and similar items of limited life. Use of other elevators by the Contractor will not be permitted.

2. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire construction period. Cooperate with the Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with the Owner's operations.

3. Partial Owner Occupancy: The Owner reserves the right to occupy and to place and install equipment in completed areas of the building, prior to Substantial Completion provided that such occupancy does not interfere with completion of the Work. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.
4. Construction employees shall not use any facilities within existing buildings, unless they are instructed to do so as part of construction or alteration work or unless otherwise indicated within the Contract Documents. This includes, but is not limited to such areas as rest rooms, cafeteria, snack bar, gift shop and waiting areas.
5. Service of electrical power, light, heat, water, gas, steam, compressed air, oxygen, suction, telephone, etc., must be maintained, except temporary shutdowns may be made after arrangements have been made with the Owner. Note that some temporary service shutdowns may require scheduling of work outside of normal working hours at Owner's cost, but with Owner's prior approval.

I. Owner's existing parking lots and roadways may be used for parking construction workers' vehicles, but only as directed by the Owner.

J. Notice of Existing Asbestos Containing Materials

1. The Owner is aware of existing asbestos-containing insulating and fire-protective materials. Work of the Contract includes remediation of such materials, described in the Owner-provided Report of Limited Asbestos-containing Material Survey, in accordance with the Asbestos Abatement Specification, Section 13281, both of which documents are included in this Project Manual.

END OF SECTION 01010

SECTION 01031 - ALTERATION WORK

PART 1 - GENERAL

1.1 DESCRIPTION:

A. The work of this Contract includes alteration work to the existing building.

1.2 INSPECTION:

A. Make adequate examination of existing building to determine scope of alteration work. Become familiar with Contract Documents and full extent of Work required.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Cutting and patching associated with new construction: Section 01045 and General Conditions.

B. Temporary Facilities: Section 01500.

1.4 TEMPORARY PROTECTION REQUIREMENTS:

A. It is the intent of the Owner to have the existing facility remain in operation while alteration work is in progress.

B. The Contractor shall construct and maintain temporary dust partitions which will isolate areas under construction to exclude dust, debris, noise and construction traffic, from other areas.

C. Where additional temporary protection is called for or required to safeguard Owner's operations it shall be the responsibility of the contractor/subcontractor performing the work to provide and maintain such protection.

D. The detailed method of providing temporary protection shall be reviewed and approved by the Owner prior to installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with Specifications and Standards for each specific material or product involved.

B. When not specified, materials used in patchwork shall match existing materials as to type, quality and appearance as determined by the Architect.

PART 3 - EXECUTION

3.1 REMOVAL AND RELOCATIONS

A. Materials Salvaged for Owner:

1. Before proceeding with removals, Owner and Contractor shall visit the areas of Work and review which items the Owner wishes to retain.
2. Remove and place such items in location designated by Owner.

B. Materials Salvaged for Reuse:

1. Drawings or Specifications will indicate materials to be salvaged for reuse.
2. Carefully remove materials indicated for reuse and store until required for reuse.

C. Materials for Disposal:

1. All removed materials not indicated to be salvaged shall be legally recycled or disposed of off the site by the Contractor.

D. Furnishings and Portable Equipment:

1. Removed from work areas by Owner.

E. Extent of Removals:

1. Remove and relocate or dispose of all building materials, equipment, fixtures, piping, conduit and other items of every description as indicated or as required to complete the work of the Contract.
2. Disconnect, cut back and cap service lines to a minimum of 1-inch behind new or patched finish materials.
3. Where equipment or materials are removed resulting in openings in exterior building elements, such as walls or roofs, openings shall be immediately sealed with weathertight temporary closures or permanent new equipment or materials by the Contractor/Subcontractor performing the removal work, unless otherwise indicated.
4. Remove and reinstall existing equipment or casework as required to allow proper installation of new or patched finish materials.

F. Methods of Removal:

1. Employ methods which will not:

   a. Cause excessive damage to adjacent existing construction or finishes.
   b. Cause excessive dust.
   c. Cause excessive noise.

2. Remove wall/partitions/flooring and ceiling work in small pieces so that remaining

adjacent existing construction is not damaged.

3.2 CUTTING AND PATCHING OF EXISTING CONSTRUCTION

A. Each Contractor/Subcontractor shall be responsible for all cutting and patching required for installation of his work. All work must be completed in a good and workmanlike manner.

B. Patching shall be done by tradesmen skilled in the work required.

C. Patch disturbed existing construction to match adjacent undisturbed construction as to materials and finishes unless otherwise indicated or approved by the Architect and Owner. Refinish entire surfaces as necessary to provide an even new finish.

1. Continuous surfaces: refinish to nearest intersection.
2. Assembly: entirely refinish.

D. Patch existing subfloors under removed partitions, fixed equipment, etc. by cutting back, applying underlayment, concrete fill or other acceptable leveling fill as necessary to provide subfloor that is level with adjacent existing subfloors and properly prepare to receive finish flooring.

E. Openings created in existing construction as a result of removal of materials shall be patched to match adjacent construction as to materials and finishes, unless otherwise indicated.

1. Furnish and install lintels where openings are cut through existing masonry or concrete walls.

F. In rooms or areas where patching is required on one wall only, that entire wall is to be refinished to match the existing finish and color, including existing painted doors, door frames and window frames if they occur in that wall.

G. In rooms or areas where patching is required on two or more walls, all walls, including painted doors, door frames and painted window frames, are to be refinished.

H. In rooms or areas where patching is required in an existing plaster or gypsum wallboard ceiling, the entire ceiling shall be repainted. In rooms where patching is required in existing acoustic tile ceilings, patch ceilings with matching type and pattern of acoustic tile, clean all remaining tile and apply one coat of white latex paint by roller over all tile surfaces. Clean all exposed metal suspension system.

I. In renovated rooms and areas to receive new wall finishes, those portions of existing walls that remain shall have their surfaces patched, cut back, or brought forward as necessary, and prepared as required to receive the new finishes to match existing adjacent construction.

J. In renovated rooms and areas to receive new floor finishes, remove existing finish flooring and related materials and prepare subfloor by cutting back, applying concrete fill or other acceptable leveling fill as necessary to provide subfloor that is level and properly prepared to receive new floor finish as required by material manufacturers written recommendations, to match existing adjacent construction.

K. When new rubber or vinyl stair treads, risers and landings, are installed at existing stairs, paint all exposed steel.

L. Paint all exposed insulated or non-insulated pipes and ducts in finished rooms or areas.

END OF SECTION 01031

SECTION 01040 - COORDINATION

1.1 DRAWINGS FOR MECHANICAL AND ELECTRICAL WORK

A. Drawings contain diagrammatic layouts and indicate general arrangement of systems, piping conduit, etc.

B. Prior to installation of material and equipment, review and coordinate work with Architectural and Structural Drawings for exact space conditions; where not readily discernable request information from Architect before proceeding.

C. Check Drawings of all other trades to verify extent of material and equipment to be installed in spaces available and consider layout alternatives so that all requirements can be accommodated.

D. Maintain maximum headroom at all locations without finished ceilings.

E. Maintain finished ceiling heights as indicated.

F. Coordinate installations with other trades to prevent conflict with work of other trades and cooperate in making reasonable modifications in layout as needed.

G. Where conflicts occur with placement of mechanical and electrical materials as they relate to placement of other building materials, the Architect shall be consulted for assistance in coordination of the available space to accommodate all trades.

1.2 PRIORITY OF CONSTRUCTION SPACE

A. Following is the Order of Priority for Construction Space:

1. First: Ductwork.
2. Second: Fire protection piping.
3. Third: Other piping.
4. Fourth: Conduit.

1.3 COORDINATION DRAWINGS

A. The ductwork contractor/subcontractor shall prepare a complete set of "Cronoflex Mylar" type background drawings at scale of minimum 1/4" equals 1'-0".

1. The construction documents in their original, copies or electronic file form are the Architect's instrument of service and are protected under copyright laws.
2. The reproduction of these documents for use as coordination drawings or shop drawings is prohibited without the Architect's written consent and authorization.

B. Each specialty trade listed below shall prepare a coordination Mylar overlay indicating his

work, with appropriate elevations and grid dimensions.

C. Each specialty trade shall sign and date the coordination Drawing after the addition of his information.

D. Fabrication shall not start until receipt of completed coordination drawings is acknowledged by the General Contractor in writing to the Architect.

E. Specialty Trades:

1. Ductwork
2. Fire protection piping
3. Other piping
4. Electrical

F. Coordination Drawings required for all mechanical rooms, electrical rooms, equipment rooms, corridors, horizontal exits from duct shafts, cross-overs and any other areas where congestion of work may occur.

END OF SECTION 01040

SECTION 01045 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 DESCRIPTION:

A. In addition to cutting and patching for alteration work, Contractor shall be responsible for all cutting, fitting and patching required to correct or modify newly installed construction, including coordination between all trades, sequential excavation and backfill, required to:

1. Complete the work or make it's several parts fit together properly.
2. Uncover portions of the work to provide for installation of ill-timed work.
3. Remove and replace defective work.
4. Remove and replace work not conforming to requirements of Contract Documents.
5. Remove samples of installed work as specified for testing.
6. Provide routine penetrations of non-structural surfaces for installation of materials such as: piping and electrical conduit.

B. Related requirements in other parts of the Project Manual:

1. Basic responsibilities of parties: Conditions of the Contract.

C. Related requirements specified in other sections:

1. Summary of Work: Section 01010.
2. Cutting and Patching for Alteration Work: Section 01031
3. Testing Laboratory Services: Section 01411.

1.2 SUBMITTALS

A. Submit a written request to Architect reasonably well in advance of executing any cutting or alteration which affects:

1. The work of the Owner or any separate Contractor.
2. The structural value or integrity of any element of the project.
3. The integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
4. The efficiency, operational life, maintenance or safety of operational elements.
5. The visual qualities of sight-exposed elements.

B. The request shall include:

1. Identification of the project.
2. Description of the affected work.
3. The necessity for cutting, alteration or excavation.
4. The effect on the work of the Owner or any separate Contractor, or on the structural or weatherproof integrity of the project.

5. Description of the proposed work:
   a. The scope of cutting patching, alteration, or excavation.
   b. The trades who will execute the work.
   c. The products proposed to be used.
   d. The extent of refinishing to be done.
6. Alternatives to cutting and patching.
7. Cost proposal, when applicable.
8. Written permission of Owner or separate Contractor whose work will be affected.
9. Proposed data and time the work will commence.

C. Should conditions of the work or the schedule indicate a change of products from the original installation, Contractor shall submit a request for substitution as specified in the General Conditions.

D. Do not proceed with the work without written consent of the Architect.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with Specifications and Standards for each specific material or product involved.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect existing conditions of the project, including elements subject to damage or to movement during cutting and patching or excavating.

B. After uncovering work, inspect the conditions affecting the installation of products, or performance of the work.

C. Report unsatisfactory or questionable conditions to the Architect in writing: do not proceed with the work until the Architect or his designee has observed the conditions.

3.2 PREPARATION

A. Provide adequate temporary support as necessary to assure the structural value or integrity of the affected portion of the work.

B. Provide temporary devices and methods to protect adjacent construction from damage, staining or soiling.

C. Provide protection from the elements for that portion of the project which may be exposed

by cutting and patching work. Maintain excavations free from debris and water.

3.3 PERFORMANCE

A. Execute cutting by methods which will prevent damage to other adjacent work, and will provide proper surfaces to receive installation of replacement work.

B. Execute excavating and backfilling by methods which will prevent settlement or damage to other work.

C. Employ the original installer or fabricator to perform cutting and patching for:

1. Weather-exposed or moisture-resistant elements.
2. Sight-exposed finished surfaces.

D. Execute fitting and adjustment of products or materials to provide a finished installation that complies with specified product's or material's, functions, tolerances and finishes.

E. Restore work which has been cut or removed: install new products or materials to provide completed work in accord with requirements of Contract Documents.

F. Refinish entire surfaces as necessary to provide an even finish to match adjacent new finishes:

1. For continuous surfaces, refinish to nearest intersection.
2. For an assembly, refinish the entire unit.

END OF SECTION 01045

SECTION 01051 - GRADES, LINES AND LEVELS

1.1 RESPONSIBILITY OF CONTRACTOR:

A. Layout location of building, structural elements, floor/roof levels and partitions as a guide for all work.

B. Verify and record all required grades.

C. Control priority location of all services in relation to each other and to related and/or adjacent construction.

D. Maintain all dimensions required by the Contract Documents.

E. Notify the Architect immediately of any discrepancies or problems in grades, dimensions or locations indicated in the Contract Documents.

END OF SECTION 01051

SECTION 01060 - REFERENCE STANDARDS

1.1 "Reference Standards" are documents or publications which include requirements set by authority, custom or general consent and establishes accepted criterion.

1.2 "Reference Standards" are incorporated into the Project Manual by reference and each reference shall mean the latest edition at date of Project Manual, including amendments and supplement.

1.3 When requested deliver to the Architect an affidavit or certificate properly signed by manufacturer or supplier indicating that the material furnished conforms to the specified standards.

1.4 Reference to manufacturer's printed Specifications for specified products shall mean most current Specification on date of this Project Manual.

END OF SECTION 01060

SECTION 01070 - ABBREVIATIONS

1.1 CONSTRUCTION ASSOCIATIONS/CODES/SPECIFICATIONS

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association of State Highway And Transportation Officials
ACI	American Concrete Institute
ADA	Americans With Disabilities Act
AGA	American Gas Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
APA	American Plywood Association
APA	Architectural Precast Association
ARI	Air Conditioning and Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating And Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWI	American Woodwork Institute
AWPI	American Wood Preservers Institute

AWS	American Welding Society
AWWA	American Water Works Association
BIA	Brick Institute of America
BHMA	Builder's Hardware Manufacturers Association
CISPI	Cast Iron Soil Pipe Institute
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standards
DOT	Department of Transportation
DPW	Department of Public Works
FDA	Food and Drug Administration
FGMA	Flat Glass Marketing Association
FM	Factory Mutual System
FS	Federal Specification
IBC	International Building Code
IEEE	Institute of Electrical and Electronic Engineers
MFMA	Maple Flooring Manufacturers Association
MIL-STD	Military Standard
NBS	National Bureau of Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NFPA	National Fire Protection Association
NWWDA	National Wood Window and Door Association

PCI	Precast Concrete Institute
PEI	Porcelain Enamel Institute
SAE	Society of Automotive Engineers
SAMA	Scientific Apparatus Makers Association
SDI	Steel Deck Institute
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SSPC	Structural Steel Painting Council
STI	Steel Tank Institute
SUCF	State University Construction Fund
UL	Underwriters Laboratories

1.2 DRAWING ABBREVIATIONS

A.B.	Anchor Bolt
A.C.	Asphaltic Concrete
AC	Air Conditioning
ACT	Acoustical Ceiling Tile or Panel
A.D.	Access Door
AD	Area Drain
ADD.	Addendum
ADJ.	Adjacent
A.F.F.	Above Finished Floor
A.G.	Accessory Group
ALT.	Alternate
ALUM.	Aluminum
APPROX.	Approximate
ARCH.	Architectural
AUTO.	Automatic
B.C.	Brick Course
BD.	Board
B.E.J.	Brick Expansion Joint

BET.	Between
BIT.	Bituminous
BLDG.	Building
BLK.	Block
BLKG.	Blocking
BM.	Beam
B.M.	Bench Mark
B.O.	By Owner
BRG.	Bearing
BRK	Brick
BS	Both Sides
BSMT.	Basement
B.T.	Bath Tub
BTM.	Bottom
BTWN.	Between
BUR	Built-Up Roofing
CAB.	Cabinet
C.B.	Catch Basin
CEM.	Cement
C.G.	Corner Guard
C.H.	Cabinet Heater
CHBD.	Chalk Board
C.I.	Cast Iron
C.JT.	Control Joint
CLG.	Ceiling
CLL	Contract Limit Line
CLR.	Clear
CM	Centimeter
CMT	Ceramic Mosaic Tile
CMU	Concrete Masonry Unit
C.O.	Clean Out
CO_2	Carbon Dioxide
COL.	Column
CONC.	Concrete
COND.	Conductive
CONT.	Continuous
CONTR.	Contractor
CONV.	Convector
CPT	Carpet
C.R.	Curtain Rod
CRS.	Course
C.S.	Counter Sink
C.S.V.	Conductive Sheet Vinyl

CT	Ceramic Tile
CW	Casework
DBL.	Double
DEM.	Demolish/Demolition
DET.	Detail
DIA.	Diameter
DIAG.	Diagonal
DIFF.	Diffuser
DIM.	Dimension
DISP.	Dispenser
D.F.	Drinking Fountain
DN.	Down
DO.	Ditto
DR.	Door
DS	Downspout
DWG.	Drawing
EA.	Each
E.I.F.S.	Exterior Insulation and Finish System
EL.	Elevation
ELEC.	Electric(al)
ELEC. CAB.	Electric Cabinet
ELEV.	Elevator
E.O.	Equipment by Owner
EPNL	Electric Panel
EQ.	Equal
EWC	Electric Water Cooler
EX	Equipment, X-Ray
EX.F.	Exhaust Fan
EXIST.	Existing
EXPD.	Exposed
EXP.JT.	Expansion Joint
EXT.	Exterior
F.A.	Fire Alarm
FB	Face Brick
F.C.U.	Fan Coil Unit
F.D.	Floor Drain
FDTN.	Foundation
FEC	Fire Extinguisher Cabinet
F.F.	Finish Floor
FHC	Fire Hose Cabinet
FHMS	Flat Head Machine Screw

FHWS	Flat Head Wood Screw
FIN.	Finish or Finished
FIN.RAD.	Fin Tube Radiation
FL.	Floor
F.N.D.	Feminine Napkin Disposal
FNV	Feminine Napkin Vendor
F.P.	Fire Proofing
FR.	Frame
FRS	Flushing Rim Sink
FT.	Foot
FTG.	Footing
FUR.	Furring
F.W.	Full Width
FWC	Fabric Wall Covering
GA.	Gage
GAL.	Gallon
GALV.	Galvanized
G.B.	Grab Bar
G.C.	General Contractor
G.I.	Galvanized Iron
GL.	Glass
GWB	Gypsum Wall Board
HB	Hose Bibb
HC	Hollow Core
H.C.	Hose Cabinet
H.C.T.	Hospital Cubicle Track
H.C.U.	Hospital Casework Unit
HDW.	Hardware
HDWD.	Hardwood
H.M.	Hollow Metal
H.PL.	Hot Plate
H.P.L.	High Pressure Plastic Laminate
HORIZ.	Horizontal
HR.	Hour
HT.	Height
HTG.	Heating
HTR.	Heater
HVAC	Heating, Ventilating & Air Conditioning
HW	Hot Water
I.D.	Inside Diameter
INCIN.	Incinerator

INS.GL.	Insulated Glass
INSUL.	Insulated(ion)
INT.	Interior
INV.	Invert
I.V.	Intravenous
JAN.	Janitor
JT.	Joint
KIT.	Kitchen
KO	Knock Out
L.	Lavatory
LAM.	Laminated
L.C.	Laboratory Casework
L.F.	Linear Feet
LG.	Long
L.GL.	Leaded Glass
LGT.	Length
LH	Left Hand
L.L.	Live Load
LLH	Long Leg Horizontal
LLV	Long Leg Vertical
L.P.	Low Point
LT.	Light
LTL.	Lintel
LT.P.	Light Panel
LTWT.	Light Weight
LVR.	Louver
MACH.	Machine
MARB.	Marble
MAS.	Masonry
MATL.	Material
MAX.	Maximum
MC	Medicine Cabinet
MECH.	Mechanical
MEMB.	Membrane
MET.	Metal
MET.TM.	Metal Trim
MFR.	Manufacturer
M.H.	Manhole
M.HP.	Mop Hopper
MIN.	Minimum

MISC.	Miscellaneous
M.O.	Masonry Opening
MOD.	Modular
MOV.	Moveable
MTD.	Mounted
M.T.P.	Metal Toilet Partition
MULL.	Mullion
MWU	Millwork Unit
NAT.	Natural
N.I.C.	Not In Contract
N.L.	Night Light
NO.	Number
NOM.	Nominal
N_2O	Nitrous Oxide
NRC	Noise Reduction Coefficient
N.T.S.	Not To Scale
O_2	Oxygen
OA	Overall
OBS.	Obscure
O.C.	On Center
O.D.	Outside Diameter
O.H.	Overhead
OHMS	Oval Head Mach Screw
OP.H.	Opposite Hand
OPP.	Opposite
OPNG.	Opening
PBD.	Particle Board
PCF	Pounds Per Cubic Foot
PCP	Precast Concrete Panel
PERF.	Perforated
PGBD.	Peg Board
PL.	Plate
PL	Property Line
P.LAM.	Plastic Laminate
PLAS.	Plaster
PLBG.	Plumbing
PMLD.	Premolded
PNL.	Panel
PNT	Paint or Painted
P.P.	Power Panel

PPT	Porcelain Paver Tile
PREF.	Prefinished
PREFAB.	Prefabricated
PROJ.	Projection
PSC	Pre-Stressed Concrete
PSI	Pounds Per Square Inch
PSF	Pounds Per Square Foot
PT.	Point
P.T.D.	Paper Towel Dispenser
P.T.R.	Paper Towel Receptor
PTN.	Partition
PVC	Polyvinyl Chloride
PVMT.	Pavement
PWD.	Plywood
QT	Quarry Tile
QTY.	Quantity
R	Riser
RA	Return Air
RAD.	Radius
RBL.	Rubble Stone
R.C.P.	Reinforced Concrete Pipe
R.D.	Roof Drain
RE:	Refer To
REC.	Recess(ed)
RECPT.	Receptacle Electric
REFR.	Refrigerator
REG.	Register
REINF.	Reinforce(ing)
REQ'D.	Required
RES.	Resilient
RET.	Return
REV.	Revision
RFG.	Roofing
RFH	Roof Hatch
RH	Right Hand
RM.	Room
RND.	Round
R.O.	Rough Opening
R.O.W.	Right Of Way
RUB.	Rubber
R.V.	Roof Vent
RVT.	Rivet

R.W.L.	Rain Water Leader
S	Sink
S.B.	Shampoo Bowl
SC	Special Coating
S.D.	Soap Dispenser
SD	Storm Drain
SDL.	Saddle
SECT.	Section
SFC	Special Floor Coating
S.G.T.	Structural Glazed Tile
SH.	Shelf, Shelving
SHR./SHWR.	Shower
SHT.	Sheet
SHTG.	Sheathing
SIM.	Similar
S.N.C.	Sanitary Napkin Cabinet
S.N.D.	Sanitary Napkin Disposer
SNT.	Sealant
SP	Stand Pipe
SPEC.	Specifications
SPKR.	Speaker
SQ.	Square
S.S.	Service Sink
S.ST.	Stainless Steel
STD.	Standard
STER.	Sterilizer
STG.	Seating
STL.	Steel
STRUCT.	Structural
SUSP.	Suspended
SV	Sheet Vinyl
SW	Switch
SWBD.	Switch Board
SWC	Special Wall Coating
SYM.	Symmetrical
T	Toilet (Fixture)
T.B.	Tackboard
TB	Towel Bar
T.D.	Tissue Dispenser
TEL.	Telephone
TEMP.	Temperature
TEMP.GL.	Tempered Glass
TER.	Terrazzo
TEX.	Texture

T&G	Tongue & Groove
THK.	Thick(ness)
THR.	Threshold
T.O.S.	Top Of Steel
T.O.W.	Top Of Wall
TP	Tangent Point
TPH	Toilet Paper Holder
TYP.	Typical
U.C.	Undercut
U/C	Under Counter
U.C.L.	Under Counter Light
U.H.	Unit Heater
UNGND.	Underground
U.O.N.	Unless Otherwise Noted
UPH.	Upholstery
UR	Urinal
U.V.	Unit Ventilator
V	Vinyl
VCT	Vinyl Composition Tile
VENT.	Ventilator
VERT.	Vertical
VEST.	Vestibule
V.T.R.	Vent Through Roof
VWC	Vinyl Wall Covering
W	Waste
W/	With
W.C.	Water Closet
W.C.D.F.	Wheelchair Drinking Fountain
WD.	Wood
WG	Wire Glass
W.L.	Water Line
W.M.P.	Wire Mesh Partition
W/O	Without
WS	Weather Strip
WSCT.	Wainscot
WT.	Weight
W.W.F.	Welded Wire Fabric

END OF SECTION 01070

SECTION 01090 - DEFINITIONS

1.1 OWNER:

A. Where the term Owner is used in the Project Manual it refers to the Environmental Protection Agency (EPA).

1.2 ARCHITECT OR ARCHITECT/ENGINEER:

A. Refers to Cannon Design, 1100 Wilson Boulevard, Arlington, Virginia 22209, who by contract with the Owner, is authorized to prepare Contract Documents for construction of this project and provide professional services as described in the Contract Documents.

1.3 PROVIDE:

A. Where the term "provide" is used it shall be understood to mean "furnish" and "install".

1.4 PROJECT MANUAL:

A. The term "Project Manual" describes the written document, of one or more volumes, which includes the Bidding Requirements, Sample Forms, Conditions of the Contract and the Technical Specifications.

1.5 PRODUCT:

A. The term "product" shall be deemed to mean all natural and manufactured materials, fixtures, equipment, devices and furnishings to be incorporated into the Work.

1.6 LANGUAGE OF PROJECT MANUAL:

A. The language of the Project Manual is of the abbreviated or streamline type and includes incomplete sentences. Omission of words or phrases such as "the Contractor Shall", "in conformity therewith", shall be", "as noted on the Drawings", "according to the Plans", "A", "an", "the", and "all" are intentional.

B. Omitted words or phrases shall be supplied by inference in the same manner as they are when a "note" occurs on the Drawings, the words "shall be" or "shall", will be supplied by inference.

C. Wherever the words "approved", "satisfactory", "directed", "submitted", "inspected" or similar words or phases are used, it shall be assured that the word "Architect" follows the verb as the object of the clause, such as "approved by the Architect" and submitted to the Architect."

END OF SECTION 01090

SECTION 01100 - ALTERNATES

1.1 GENERAL

A. Related Requirements Specified Elsewhere:

1. Basis of Award: Instructions to Bidders.
2. Summary of Work: Section 01010.
3. Pertinent requirements for materials and methods: Various specification sections.

1.2 DESCRIPTION

A. This section describes the changes to be made under each alternate.

B. Alternate proposals shall include the difference in price (addition or deduction) from the Base Bid, for substituting, omitting or adding to materials or construction required by the Bidding Documents as part of the Base Bid construction work.

C. The difference in price shall include all omissions, additions, adjustments of all trades as may be necessary because of each change.

D. Coordinate pertinent related work and modify surrounding work as required to complete the project under each alternate designated in the Owner-Contractor agreement.

E. Alternates Described Under Other Divisions.

1. For description of alternates related to Plumbing and Drainage; Heating, Ventilating, and Air Conditioning; and Electrical work refer to Divisions 15 and 16 entitled Alternate Information.

F. Description of Alternates:

Alternate Number 1: Contractor shall provide alternate pricing for providing area drains, cleanouts, and associated piping, excavation and backfill as shown on drawing M101.

END OF SECTION 01100

SECTION 01310 - CONSTRUCTION PROGRESS SCHEDULE

1.1 Contractor shall prepare and submit, for Owner's information, a construction progress schedule for the work under his Contract.

1.2 Submittal shall be as soon as practicable after award of contract, but in no case later than 10 days after commencement of construction.

1.3 Construction progress schedule shall relate to the entire project to the extent required by the Contract Documents and shall provide for expeditious and practicable execution of the work.

1.4 Construction progress schedule shall be updated monthly if necessary due to changes.

1.5 Percent complete shall be based on actual construction in place of the work relative to the total.

END OF SECTION 01310

SECTION 01340 - SUBMITTALS

1.1 GENERAL

A. Submit, to the Architect, as directed below, shop drawings, product data and samples required by specification sections.

B. Shop Drawing, Product Data and Sample Submittal Schedule:

1. Prepare and submit, in accordance with the approved Project Construction Schedule, a separate document listing dates by which shop drawings, product data and samples must be submitted for each material, product or equipment item requiring submittal.
2. The schedule shall reflect an orderly sequence so as to cause no delay in the Work.
3. The dates indicated shall allow reasonable time for the review process of checking, correcting and resubmitting and reasonable time for procurement.
4. No extension of time will be granted to the Contractor/Subcontractor because of failure to expeditiously submit shop drawings and samples in reasonable time to allow for review process.

C. Related Requirements Specified Elsewhere:

1. General Conditions and Supplementary Conditions.
2. Construction Schedule: Section 01310.
3. Schedule of Values: Section 01370.
4. Project Record Documents: Section 01720.
5. Required Mechanical and Electrical Submittals: Division 15 and 16.

D. Required Submittals: All required submittals are listed and described in each specification section. DO NOT SUBMIT ITEMS UNLESS THEY ARE REQUIRED BY THE SPECIFICATION SECTION. Submittals which are not required will not be reviewed or returned.

1.2 SHOP DRAWINGS

A. Shop drawings are drawings, diagrams, schedules and other data specifically prepared for the Work by the Contractor, Subcontractor, sub-subcontractor, manufacturer, supplier or distributor, to illustrate some portion of the work, showing fabrication, layout, setting and erection details.

B. Identify details by reference to drawing sheet number(s) and pertinent detail number(s).

C. Shop drawings shall not include the phrase "by others", except when relating to materials, products or equipment not included under the total Contract.

1.3 PRODUCT DATA

A. Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the Contractor/Subcontractor to illustrate materials, products, or equipment for some portion of the Work.

B. Manufacturer's Standard Construction Drawings:

1. Modify drawings to delete information which is not applicable to this project.
2. Supplement standard information to provide additional information applicable to this project.

C. Submit manufacturer's catalog sheets, brochures, diagrams, schedules, performance charts, illustrations and other standard description data in accordance with the following:

1. Clearly mark each copy to identify pertinent materials, products, models or equipment.
2. Show dimensions and clearances required by code requirements.
3. Show performance characteristics and capacities.
4. Show wiring diagrams and controls.
5. Include color charts or chips for color selection where colors are not preselected.

1.4 SAMPLES

A. Samples are physical examples which illustrate materials, product or equipment workmanship, and shall establish standards by which Work will be judged.

B. Office samples of sufficient size and quantity to clearly illustrate:

1. Functional characteristics of product, material, or equipment with integrally related parts and attachment devices.
2. Full range of color samples as specified.

C. Field Samples and Mock-ups:

1. Erect at project site at location acceptable to Architect.
2. Construct each field sample or mock-up complete; including work of all trades required in finished work.
3. When directed by Architect, demolish field sample or mock-up and remove from project site, unless accepted by the Architect as part of the completed work.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Review shop drawings, product data and samples, for conformance with the Contract Documents, prior to submission and stamp reviewed.

B. Submittals shall include Cannon submittal identification sheet with Contractor's/Subcontractor's stamp of review. Submittals lacking this sheet will not be

reviewed and will be returned for resubmission.

C. Verify:

1. Field Measurements.
2. Field Construction Criteria.
3. Catalog Numbers and Similar Data.
4. Quantities.

D. Coordinate each submittal with requirements of Project Construction Schedule and Contract Documents.

E. Contractor's responsibility regarding errors and omissions in submittals is not relieved by Architect's review of submittals.

F. Contractor's responsibility regarding deviations in submittals from requirements of Contract Documents is not relieved by Architect's review of submittals, unless Architect gives written acceptance of specific deviations as approved by Owner.

G. When work is directly related and involves more than one trade, shop drawings shall be coordinated by the submitting Contractor/Subcontractor with other trades prior submission and related work submitted under one cover.

H. After a shop drawing has been submitted for review, no changes may be made to that Drawing other than changes resulting from review notes made by the Architect unless such changes are clearly identified and circled before being resubmitted. Any failure to comply with this requirement shall nullify and invalidate the Architect's review.

1.6 SUBCONTRACTOR'S RESPONSIBILITIES

A. Review shop drawings, products data and samples, for conformance with the Contract Documents prior to submission and stamp reviewed.

B. Submittals without Subcontractor's stamp of review will not be reviewed and will be returned for resubmission.

C. Verify:

1. Field Measurements.
2. Field Construction Criteria.
3. Catalog Numbers and Similar Data.
4. Quantities.

D. Coordinate each submittal with requirements of Project Construction Schedule work and Contract Documents.

E. Subcontractor's responsibility regarding errors and omissions in submittals is not relieved by Architect's and Contractor's review of submittals.

F. Subcontractor's responsibility regarding deviations in submittals from requirements of Contract Documents is not relieved by Architect's and Contractor's review of submittals, unless Architect gives written acceptance of specific deviations as approved by Owner.

G. When work is directly related and involves more than one trade, shop drawings shall be coordinated by the submitting Subcontractor with other trades prior to submission and related work submitted under one cover.

1. After a shop drawing has been submitted for review, no changes may be made to that Drawing other than changes resulting from review notes made by the Architect and Contractor unless such changes are clearly identified and circled before being resubmitted. Any failure to comply with this requirement shall nullify and invalidate the Architect's and Contractor's review.

1.7 SUBMISSION REQUIREMENTS:

A. Quantity to Architect

1. Shop Drawings: 1 reproducible transparency and (1) blue/black line print.
2. Product Data: (5) copies.
3. Samples: (2) each unless otherwise indicated in Specification sections.

B. Accompany submittals with transmittal letter, in the form of the one at the end of this section which will be distributed by the Architect, in duplicate, containing the following:

1. Date.
2. Project title and number.
3. Contractor's name and address.
4. The number of each shop drawing, product data, material, product or equipment sample submitted.
5. Specification section number, article or paragraph numbers.
6. Notification of deviations from Contract Documents.
7. Other required data, as specified.

C. Submittals Shall Include:

1. Date and revision dates.
2. Project title and number.
3. The Names of:
   a. Architect.
   b. Contractor.
   c. Subcontractor.
   d. Supplier.
   e. Manufacturer.

4. Identification of material, product or equipment.
5. Relation to adjacent structure, materials, product or equipment.
6. Field dimensions, clearly identified as such.
7. Specification section number, article or paragraph number(s).
8. Applicable standards, such as ASTM number or Federal Specification number.
9. Sufficient blank space, for the Architect's stamp.
10. Identification of deviations from Contract Documents.
11. Contractor's stamp, initialed or signed, certifying review of submittal, verification of field measurements and compliance with Contract Documents.

1.8 REVIEW PROCEDURE: BY ARCHITECT/ENGINEER

A. Stamped Reviewed "No Exceptions Taken": No corrections or resubmissions required, fabrication may proceed.

B. Stamped Reviewed "Make Corrections Noted":

1. If Contractor/Subcontractor complies with noted corrections, fabrication may proceed and resubmission is not required, unless otherwise noted.
2. If for any reason the Contractor/Subcontractor cannot comply with the noted corrections, fabrication shall not proceed and Contractor/Subcontractor shall resubmit, following procedures outlined hereinbefore.

C. Stamped Reviewed "Revise and Resubmit" :

1. Contractor/Subcontractor shall revise and resubmit for review. Fabrication shall not proceed.

D. Stamped "Rejected": Submittal is not in compliance with the Contract Documents, and is not acceptable. Resubmit Contract compliant material.

E. Stamped "For Record Only". Submittal has been received and will be retained for record keeping purposes.

1.9 RESUBMISSION REQUIREMENTS:

A. Shop Drawings:

1. Revise or produce new shop drawings as required and resubmit as specified for initial submittal.
2. Identify on drawings all changes which have been made on documents.

B. Material/Product or Equipment Samples:

1. Submit new samples as directed via initial submittal requirements.

1.10 DISTRIBUTION OF SUBMITTALS AFTER ARCHITECT'S REVIEW, BY THE ORIGINAL SUBMITTER.

A. Distribute copies of submittals which carry Architect's reviewed stamp, to:

1. Contractor's File.
2. Job-Site File. (Record Copy)
3. Related Contractor's/Subcontractor's File.
4. Supplier.
5. Fabricator.
6. Owner's representative.

B. Distribute samples as directed.

1.11 ARCHITECT RESPONSIBILITIES:

A. Review submittals with reasonable promptness.

B. Review for:

1. Design Concept of Project.
2. Information Required by Contract Documents.

C. Review of separate item(s) does not constitute review and/or acceptance of an assembly in which item(s) function.

D. Affix stamp with reviewer's initials or signature certifying to review of submittal.

E. Return of submittals to Contractor for distribution.

1.1 TRANSFER OF ELECTRONIC FILES

A. Cannon Design, (list additional consultants) will provide electronic files for Contractor's, Subcontractor's or Vendor's use in the preparation of shop and record drawings related to the project, subject to a $50.00 charge per drawing file and the following terms and conditions:

1. The Architect will provide electronic files in AutoCAD DWG format. The architect makes no representation as to the compatibility of these files with the Contractor's hardware or software.

2. Data contained on these electronic files are part of Cannon Design's, (list additional consultants) instruments of service and shall not be used by the contractor or anyone else receiving data through or from the contractor for any purpose other than as convenience in the preparation of shop and record drawings

for the reference project. Any other use or reuse by the Contractor or by others will be at their sole risk and without liability or legal exposure to Cannon Design, (list additional consultants). The Contractor agrees to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against Cannon Design, (list additional consultants) or their officers, directors, employees, agents or sub-consultants, which may arise out of or in connection with their use of the electronic files.

3. These electronic files are not contract documents. Significant difference may arise between these electronic files and corresponding hard copy contract documents due to addenda, change orders or other revisions. Cannon Design, (list additional consultants) make no representation regarding the accuracy or completeness of the electronic files you receive. In the event that a conflict arises between the signed contract documents prepared by Cannon Design, (list additional consultants) and electronic files, the signed contract documents shall govern. The Contractor is responsible for determining if any conflicts exist. By use of these electronic files, Contractor's are not relieved of their duty to comply with the contract documents, including and without limitation, the need to check, confirm and coordinate all dimensions and details, take field measurements, field verify conditions and coordinate the Contractor's work with that of the other contractors for the project.

4. Before release of the drawings, contractors, subcontractors and vendors will be asked to sign a form assenting to these conditions.

END OF SECTION 01340

SECTION 01370 - SCHEDULE OF VALUES

1.1 GENERAL

A. Related Requirements Specified Elsewhere

1. Construction Schedules: Section 01310.

B. Submit schedule of values to the Architect at least fifteen (15) days prior to submitting first application for payment.

1. Schedule of values will be broken down into separate amounts for labor, materials and other costs.

C. Upon request by Architect, submit data that will substantiate values given.

D. Use schedule of values only as basis for Contractor's application for payment.

1.2 FORM OF SUBMITTAL

A. Submit typewritten schedule of values on AIA Document G702/703, unless directed otherwise.

END OF SECTION 01370

SECTION 01400 - QUALITY CONTROL

1.1 EXAMINATION OF SUBSTRATE:

A. Installers of Materials, Products or Equipment Shall:

1. Examine base surfaces on which their materials, products or equipment are to be installed.
2. Examine conditions under which their materials, products or equipment are to be installed.
3. Verify field dimensions.
4. Where there is any question as to the dryness of a surface, test with a modern moisture indicating device.
5. Notify Contractor, with copy to Architect, if conditions are detrimental to proper and timely construction and completion of the work.

B. Do not proceed with work until unsatisfactory substrate, or unacceptable conditions, have been corrected.

C. Commencement of installation constitutes acceptance of substrate and conditions and the cost of any corrective work due to faulty base surfaces or improper conditions shall be borne by the installer applying its materials, products or equipment thereon.

END OF SECTION 01400

SECTION 01411 – SPECIAL INSPECTIONS AND TESTING

1.1 RELATED DOCUMENTS

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

1.2 GENERAL REQUIREMENTS

A. Provide special inspections and testing in accordance with Chapter 17 of the International Building Code 2000.

B. The program of Special Inspection and Testing is a Quality Assurance program intended to ensure that the work is performed in accordance with the Contract Documents.

C. This specification section is intended to inform the Contractor of the Owner's quality assurance program and extent of the Contractor's responsibilities. This specification section is also intended to notify the Special Inspectors, Testing Laboratory, and other Agents of the Special Inspectors of their requirements and responsibilities.

1.3 SCHEDULE OF INSPECTIONS AND TESTS

A. Required inspections and tests are described in the individual specification sections for the items to be inspected or tested.

B. The Engineer of Record will determine the locations for taking sample specimens for testing in accordance with the specifications.

1.4 QUALIFICATIONS

A. The Special Inspectors shall be qualified persons hired directly by the Contractor who demonstrate competence to the satisfaction of the Engineer of Record (EOR) and Resident Engineer.

B. The testing laboratory shall retain the services of a full time registered Professional Engineer who shall certify all test reports. The Engineer shall be responsible for the training of the testing technicians and shall be in responsible charge of the field and laboratory testing operations.

C. Special inspections shall be performed by Special Inspectors who are certified as identified below, or are working under the direction of a registered Professional Engineer.

1. Technicians performing sampling and testing of concrete shall be ACI certified Concrete Field Testing Technicians – Grade 1.

2. Inspectors performing inspections of concrete work such as inspections of concrete placement, batching, reinforcing placement, curing and protection, shall be ACI certified Concrete Construction Inspectors or ICBO certified Reinforced Concrete Special Inspectors.

3. Inspectors performing inspections of prestressed concrete work shall be ICBO/BOCA/SBCCI certified Prestressed Concrete Special Inspector.

4. Inspectors performing inspections of masonry shall be ICBO certified Structural Masonry Special Inspectors.

5. Technicians performing visual inspection of welding shall be AWS Certified Welding Inspectors or ICBO certified Structural Steel and Welding Special Inspectors; technicians performing non-destructive testing such as ultrasonic testing, radiographic testing, magnetic particle testing, or dye-penetrate testing shall be certified as an ASNT-TC Level II or Level III technician.

6. Inspectors performing inspections of spray fireproofing shall be ICBO certified Spray-Applied Fireproofing Special Inspector.

7. Technicians performing standard tests described by specific ASTM Standards shall have training in the performance of such tests and must be able to demonstrate either by oral or written examination competence for the test to be conducted. They shall be under the supervision of a licensed Professional Engineer and shall not be permitted to independently evaluate test results.

1.5 SUBMITTALS

A. The Special Inspectors and Testing Laboratories shall submit to the EOR and Resident Engineer for review a copy of their qualifications which shall include the names and qualifications of each of the individual inspectors and technicians who will be performing inspections or tests.

B. The Special Inspectors and Testing Laboratories shall disclose any past or present business relationship or potential conflict of interest with the Contractor or any of the Subcontractors whose work will be inspected or tested.

1.6 PAYMENT

A. The Contractor will engage, at his own expense, the services of the Special Inspectors and Testing Laboratories.

B. If any materials which require Special Inspections are fabricated in a plant which is not located within 100 miles of the project, the Contractor is responsible for the travel expenses

of the Special Inspectors or Testing Laboratories.

C. The cost of any retesting or reinspection of work which fails to comply with the requirements of the Contract Documents is the responsibility of the Contractor.

1.7 CONTRACTOR RESPONSIBILITIES

A. Cooperate with the Special Inspectors and Testing Laboratories so that the Special Inspections and testing may be performed without hindrance.

B. Review the Statement of Special Inspections and be responsible for coordinating and scheduling inspections and tests. Notify the Special Inspectors or Testing Laboratories at least 24 hours in advance of a required inspection or test. Uninspected work that required inspection may be rejected solely on that basis.

C. Provide incidental labor and facilities to provide safe access to the work to be inspected or tested, to obtain and handle samples at the site or at source of products to be tested, to facilitate tests and inspections, storage and curing of test samples.

1. Construct a storage box on site of sufficient size to store concrete cylinders which will afford protection as required by ASTM C-31.

2. Provide the laboratory with representative initial samples, in requested quantities.

3. When source, quality or characteristic of an approved material changes or indicates lack of compliance with Contract requirements, submit additional samples of materials to testing laboratory.

4. Patch area where samples are taken for purposes of testing to the satisfaction of the Architect.

D. Retain the latest set of construction drawings, field sketches, approved shop drawings, and specifications at the project site for use by the inspectors and testing technicians.

E. The Special Inspection program does not, in any way, relieve the Contractor of his obligation to perform work in accordance with the requirements of the Contract Documents or from implementing an effective Quality Control program. All work that is to be subjected to Special Inspections shall first be reviewed by the Contractor's quality control personnel.

F. The sole responsibility for construction site safety belongs to the Contractor.

1.8 LIMITS ON AUTHORITY

A. The Special Inspectors or Testing Laboratories may not release, revoke, alter, or enlarge on

the requirements of the Contract Documents.

B. The Special Inspectors or Testing Laboratories will not have control over the Contractor's means and methods of construction.

C. The Special Inspectors or Testing Laboratories are not responsible for construction site safety.

D. The Special Inspectors or Testing Laboratories have no authority to stop the work.

1.9 RECORDS AND REPORTS

A. Submit daily reports of each inspection or test to the registered design professional in responsible charge. Reports shall include:

1. Date of test or inspection.
2. Name of inspector or technician.
3. Location of specific areas tested or inspected.
4. Description of test or inspection and results.
5. Applicable ASTM standard.
6. Weather conditions.
7. Signature of special inspector or technician.

B. Submit interim reports to the Resident Engineer at the end of each week which include all inspections and test reports received that week. Provide copies to the EOR, Architect, and Contractor.

C. Any discrepancies from the Contract Documents found during a Special Inspection shall be immediately reported to the Contractor. If the discrepancies are not corrected, the Special Inspector shall notify the EOR and Resident Engineer. Reports shall document all discrepancies identified and the corrected action taken.

D. The Testing Laboratory shall immediately notify the registered design professional in responsible charge by telephone or fax of any test results which fail to comply with the requirements of the Contract Documents.

E. Reports shall be submitted to the registered design professional in responsible charge within 7 days of the inspection or test. Hand written reports may be submitted if final typed copies are not available.

F. Provide a statement to the registered design professional in responsible charge at the completion of the work requiring Special Inspections from each inspection agency and testing laboratory that all work was completed in substantial conformance with the Contract Documents and that all appropriate inspections and tests were performed.

1.10 FINAL REPORT OF SPECIAL INSPECTIONS

A. Complete Final Report of Special Inspections by the registered design professional in responsible charge and submit to the EOR and Resident Engineer prior to the issuance of a Certificate of Use and Occupancy.

B. Use C.A.S.E. Form 102 – 2001 for the Final Report of Special Inspections.

C. The Final Report of Special Inspections will certify that all required inspections have been performed and will itemize any discrepancies that were not corrected or resolved.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION (NOT APPLICABLE)

SECTION 01500 - TEMPORARY FACILITIES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS SPECIFIED ELSEWHERE:

A. General Conditions of the Contract for Construction.

B. Supplementary Conditions.

C. Summary of Work: Section 01010.

1.2 DESCRIPTION OF SYSTEMS:

A. Temporary Power and Lighting: Contractor to obtain power from Owner approved existing source(s); establish distribution system and modify/extend as required; provide system and materials complying with U.L., OSHA and local code requirements; maintain throughout construction; provide adequate lighting (especially during finish work).

1. Owner will pay local Utility bills for power consumed for temporary power and lighting.

B. Temporary Telephone Service: Owner will provide a telephone for use by Contractor, in a designated area.

1. Contractor, as a minimum, will be required to pay for all long distance phone calls.

2. If pay phone, Contractor will pay for all phone calls.

C. Temporary Sanitary Facilities: Owner will designate existing toilet facilities for use of construction personnel. Contractor will be responsible for damages to existing facilities attributable to use by construction personnel.

D. Temporary Fire Protection: Contractor shall continuously maintain existing exit ways and fire protection for existing building; maintain general construction fire protection in accordance with local, state and federal codes and regulations. Each Contractor/Subcontractor will provide for his required specialty needs.

E. Temporary Ladders and Chutes: Contractor shall provide required temporary ladders and chutes. All temporary ladders and chutes must comply with OSHA requirements.

F. Temporary Closures: Contractor shall provide temporary weather tight closures for exterior wall and roof openings. Equip exterior door openings with self-closing hardware and padlocks.

G. Temporary Field Offices and Construction Storage: Owner will make existing space available to Contractor for use as a temporary field office. Contractor, as approved by the Owner, shall provide his own temporary office equipment, furnishings, and facilities as required to suite his needs. Owner will designate space for storage of construction materials, either inside existing building or outside in Owner approved sheds or trailers that the Contractor must provide.

1. Contractor is responsible for maintenance of the Contractor's temporary equipment, furnishings and facilities.

PART 2 PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.1 Install temporary facilities in proper and functional manner.

3.2 Maintain to give continuous services and provide safe working conditions.

3.3 Modify, extend or move throughout course of work as required and applicable.

3.4 Remove upon completion of work or when directed by Contractor or Owner.

3.5 Restore existing facilities to original condition, when damaged by Contractor's use.

END OF SECTION 01500

SECTION 01600 - MATERIAL, PRODUCTS AND EQUIPMENT

1.1 MATERIAL, PRODUCTS AND EQUIPMENT STANDARDS

A. All materials, products and equipment furnished and/or installed for this project must be 100 percent free of asbestos containing materials.

B. Materials, products and equipment shall conform with the manufacturer's current detailed specifications on date of this Project Manual unless specifically indicated otherwise.

C. Electrical work shall be UL labeled or listed, as required by the National Electric Code at time of installation.

D. Work which requires connection for electrical outlets shall be furnished with grounded power plug and proper connecting line.

1.2 DELIVERY AND STORAGE OF MATERIALS, PRODUCTS AND EQUIPMENT

A. All materials, products and equipment shall be carefully handled and protected from damage and weather as required by manufacturers specifications and recommendations during loading, delivery, unloading, storage and installation.

B. Contractor shall designate space(s) for storage of materials, products and equipment, allotting space to Contractors.

C. Store all materials, products and equipment in a neat and orderly manner.

D. Any relocation of stored materials necessitated by progress of the Work will be accomplished promptly by the appropriate Contractor/ Subcontractor without additional compensation.

E. Materials, products and equipment items that are normally packaged, shall be delivered to the project site in manufacturer's sealed containers, plainly labeled with manufacturer' name and brand name.

F. Coordinate deliveries to the site with the Contractor and deliver in ample time to allow examination by the Architect and Owner prior to incorporation into the work.

G. Any materials which the Contractor determines cannot be received on site will be stored off site, per the above paragraphs, in a place paid for by the appropriate Contractor/Subcontractor at no extra cost to the Owner, until they can be received on the site for storage or installation. Each Contractor/Subcontractor shall insure material stored off site against damage or loss, and provide record of material insurance to the Construction Manager.

H. All Contractors/Subcontractors will provide the Owner with copies of signed material receipts when requested by Owner.

I. Except as otherwise specified, each Contractor/Subcontractor shall be responsible for his equipment, tools and supplies used on the site and for his materials whether stored or incorporated into the Work, until the building is completed and accepted by the Owner.

1.3 INSTALLATION

A. All manufactured articles, material, products and equipment shall be applied, installed, connected, erected, cleaned and conditioned as recommended by the manufacturer, unless specifically specified to the contrary.

B. Manufacturer's labels shall not appear on exposed surfaces of the finished work, except in unfinished portions of the building, such as mechanical equipment rooms.

C. Install materials, products and equipment so it is readily accessible for operation, maintenance and repair. Minor deviations from Drawings may be made to accomplish this, but changes involving extra cost shall not be made without prior written approval.

1.4 SUBSTITUTIONS

A. Refer to Supplementary Conditions.

END OF SECTION 01600

SECTION 01700 - PROJECT CLOSEOUT

1.1 RELATED REQUIREMENTS AND ADDITIONAL SPECIFICATIONS; REFER TO OTHER SECTIONS OF GENERAL REQUIREMENTS, GENERAL AND SUPPLEMENTARY GENERAL CONDITIONS.

A. Time of Final Payment: Owner - Contractor Agreement.

B. Completion: Waiver of Claims: General Conditions.

C. Cleaning: Section 01710.

D. Project Record Documents: Section 01720.

E. Operation and Maintenance Data: Section 01730.

F. Warranties: Section 01750.

G. Closeout submittals required for trades: Respective section of Specifications.

H. Substantial Completion: General and Supplementary Conditions.

I. Final Completion: General and Supplementary Conditions.

1.2 SUBSTANTIAL COMPLETION

A. Contractor:

1. Submit written notification to Architect that project, or designated portion of project, is substantially complete. Include a list of all items to be completed or corrected for final completion.

B. Architect will make an inspection within 7 days after receipt of notification from Contractor that work is substantially complete, together with Owner's representative.

C. Should Architect consider that work is substantially complete:

1. Architect will prepare and issue a certificate of substantial completion, containing:

a. Date of substantial completion.
b. Contractor's list of items to be completed or corrected, verified and amended by Architect's list requiring completion or correction.
c. The time within which Contractor shall complete or correct work of listed items.
d. Time and date Owner will assume possession of work or designated

portion thereof.

e. Responsibilities of Owner and Contractor for:

(1) Insurance.
(2) Utilities.
(3) Operation of mechanical, electrical and other systems.
(4) Maintenance and cleaning.
(5) Security.

f. Signatures of:

(1) Architect.
(2) Contractor.
(3) Owner.

2. Owner occupancy of project or designated portion of project:

a. Contractor shall:

(1) Perform final cleaning in accordance with Section 01710.

b. Owner shall:

(1) Obtain and execute certificate of occupancy.
(2) Owner will occupy project, under provisions stated in certificate of substantial completion.

3. Contractor: complete work listed for completion or correction, and all other contract construction within designated time.

D. Should Architect Consider That Work Is Not Substantially Complete:

1. He shall immediately notify Contractor, in writing, stating reasons.
2. Contractor: Immediately complete work, and send second written notice to Architect, notifying that project, or designated portion of project, is substantially complete.
3. Architect will re-inspect work.

1.3 FINAL COMPLETION

A. Contractor shall submit written notification in the form of a Final Contractor's Certification Letter and in accordance with Article 9.9 of General and Supplementary General Conditions that:

1. Contract Documents have been reviewed.
2. Project has been inspected for compliance with Contract Documents.
3. Work has been completed in accordance with Contract Documents requirements.
4. Equipment and systems have been tested in presence of Architect and Owner's representative and are operational and approved by representatives.

5. Project is completed, and ready for final inspection.

B. Architect with Owner's representative will make final inspection within 7 days after receipt of notification.

C. Should Architect and Owner's representative consider that work is finally complete in accordance with requirements of Contract Documents, the Architect will issue a Final Architect's Certification Letter and request the Contractor to make project closeout submittals.

D. Should Architect consider that work is not finally complete:

1. He shall notify Contractor, in writing, stating reasons.
2. Contractor shall take immediate steps to remedy the stated deficiencies, and send second written notice to Architect notifying that work is complete.
3. Architect and Owner's representative will re-inspect work.

1.4 REINSPECTION COSTS

A. Should Architect be required to perform second inspection because of failure of work to comply with original notification of Contractor, Owner will compensate Architect for additional services, and deduct amount paid from final payment to Contractor.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: as required by Section 01720.

B. Operation and Maintenance Data: as required by Section 01730.

C. Warranties: as required by Section 01750.

D. Parts and maintenance materials: as required by specification sections.

E. Keys and keying schedule: as required by Resident Engineer.

F. Deliver certificates of compliance with requirements of governing authorities, as required by respective Specification sections, including, but not limited to:

1. Certificates of Inspection:

a. Plumbing and Drainage.
b. Mechanical.
c. Electrical.

1.6 EVIDENCE OF PAYMENT AND RELEASE OF LIENS

A. Contractor's affidavit of payment of debts and claims: AIA G706.

B. Contractor's affidavit of release of liens: AIA G706A, with:

1. Consent of Surety to Final Payment: AIA G707.
2. Contractor's Release or Waiver of Liens.
3. Separate releases of waivers of liens for subcontractors, suppliers, and others with lien rights against property of Owner, together with list of those parties.

C. All submittals shall be duly executed before delivery to Architect.

1.7 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit final statement of accounting to Architect.

B. Statement shall reflect all adjustments, including:

1. Original Contract sum.
2. Additions and deductions resulting from (if applicable):

   a. Previous change orders.
   b. Cash allowances.
   c. Unit prices.
   d. Other adjustments.
   e. Deductions for uncorrected work.
   f. Penalties and bonuses.
   g. Deductions for liquidated damages.
   h. Deductions for re-inspection payments.

3. Total Contract sum, as adjusted.
4. Previous payments.
5. Sum remaining due.

C. Architect will prepare final change order, reflecting approved adjustments to contract sum not previously made by change orders.

1.8 FINAL APPLICATION FOR PAYMENTS

A. Contractor shall submit final application in accordance with requirements of General and Supplementary Conditions.

1.9 FINAL CERTIFICATE FOR PAYMENT

A. Architect will issue final certificate in accordance with provisions of General and Supplementary Conditions.

B. Should final completion be materially delayed through no fault of the Contractor, Architect may issue a semi-final certificate for payment, in accordance with provisions of General and Supplementary Conditions.

1.10 POST-CONSTRUCTION INSPECTION

A. Prior to expiration of 1 year from date of substantial completion, Architect at request of Owner will make visual inspection of project in company with Owner and Contractor to determine whether correction of work is required, in accordance with provisions of General/ Supplementary Conditions and Contract Documents.

B. For guarantees beyond 1 year, Architect will make inspections at request of Owner, after notification to Contractor.

C. Architect will promptly notify Contractor, in writing, of any observed deficiencies.

END OF SECTION 01700

SECTION 01710 - CLEANING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. General Requirements of Cleaning: General Conditions.

B. Clean Up Required by Specific Trades: respective sections of Specifications.

1.2 COST

A. Cost of providing containers and disposing of waste from containers, responsibility of:

1. Contractor.

B. Cost of placing waste materials in containers, responsibility of:

1. Contractor.

C. Cost of Final Cleaning, Responsibility of:

1. Contractor.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

A. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

B. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 - EXECUTION

3.1 DURING CONSTRUCTION

A. Provide sufficient quantity of waste containers on site and on each floor of building or in each area of work for collection of waste materials, rubbish and debris.

B. Contractor shall remove waste and surplus materials. Removal shall be at least once a week, and more often if same interferes with the work, or presents a fire or safety hazard. Place waste materials in containers provided for this purpose.

C. Remove waste materials from containers and dispose of off site, at least once a week and more often if same interferes with the work or presents a fire or safety hazard.

D. Lower waste materials from building in a controlled manner. Do not drop or throw materials from heights.

E. Clean all debris from spaces to be closed in.

3.2 FINAL CLEANING

A. Period of Cleaning:

1. At completion of construction just prior to acceptance or occupancy.
2. Owner occupancy prior to final completion.

   a. Should the Owner desire to occupy substantially completed portions of the work prior to the date of final completion, upon written notice from the Architect, perform the final cleaning in those areas.
   b. After final cleaning those portions of the building and after the areas have been occupied by the Owner, no other cleaning will be required in those areas, except where cleaning is required as a result of additional or correctional work.
   c. If additional cleaning is required due to additional or corrective work, cleaning shall be responsibility of Contractor/Subcontractor performing such work.

B. Extent of Cleaning:

1. Thoroughly clean carpet by vacuuming.
2. Thoroughly broom clean and wash other floors.
3. Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials from interior and exterior surfaces, including but not limited to:

   a. Glass.
   b. Finish hardware.
   c. Painted surfaces.
   d. Flooring.
   e. Fixtures.
   f. Equipment.

C. Broom clean exterior paved surfaces.

END OF SECTION 01710

SECTION 01720 - PROJECT RECORD DOCUMENTS

1.1 GENERAL

A. Contractor shall maintain at the site, for the Owner, Construction Manager and Architect, one record copy of:

1. Prints of drawings including delineated "As Built" modifications.
2. Specifications including delineated "As Built" modifications.
3. Addenda.
4. Change orders and other modifications to the Contract.
5. Architect's written field orders or instructions.
6. Reviewed Shop Drawings, Product Data and Samples.
7. Field test records.
8. Construction photographs.

B. Related Requirements in Other Parts of the Project Manual:

1. General/Supplementary Conditions of the Contract.

C. Related Requirements Specified in Other Sections:

1. Submittals: Section 01340.
2. Project Close Out: Section 01700.
3. Detailed Requirements: Division 15, Mechanical and Division 16, Electrical.

1.2 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Store Contract Documents and samples in Contractor's field office apart from documents used for construction.

1. Provide files and racks for storage of documents.
2. Provide secure storage space for storage of samples.

B. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.

C. Within one day's notice, during the course of the work, current record documents shall be made available for inspection by Owner and Architect.

1.3 RECORDING "AS BUILT" MODIFICATIONS

A. Label each document "As Built Record" in neat, large printed letters.

B. Record information concurrently with construction progress.

1. Do not conceal any work until required information is recorded.

C. Drawings: Legibly marked to record all deviations to current Contract Documents showing actual construction.

1. Depths of various elements of foundation in relation to finish first floor datum.
2. Horizontal and vertical location of underground utilities and appurtenances, referenced to permanent surface improvements.
3. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.
4. Changes made by addenda.
5. Field changes of dimension and detail.
6. Changes made by field order or by change order.
7. Details not on original Contract Drawings.

D. Project Manual: Legibly mark each section to record:

1. Changes made by addenda.
2. Changes made by written field order or by change order.

1.4 CERTIFICATION

A. Certify as a part of each application for payment that project record documents are current at time application is submitted. Include the requirements of paragraph 3 entitled "Recording As Built Modifications".

1.5 SUBMITTAL: "AS BUILT" DOCUMENTS

1. At completion of the project, the Contractor shall purchase an AUTOCAD, Version 200I copy of the Drawings from the Architect for the purpose of transferring “As Built” modifications made to the original Contract drawings during the construction period.

B. Forward original marked-up prints plus set of reproducible copies to Architect for review.

C. Upon completion of Architect's review, all submitted documents will be forwarded to the Owner for review, approval and ownership.

1. Accompany submittal with transmittal letter in duplicate containing:

a. Date.

b. Project title and number.

c. Title and number of each record document.

1.6 TRANSFER OF ELECTRONIC FILES

A. Cannon Design, (list additional consultants) will provide electronic files for Contractor's, Subcontractor's or Vendor's use in the preparation of shop and record drawings related to the project, subject to a $50.00 charge per drawing file and the following terms and conditions:

1. The Architect will provide electronic files in AutoCAD DWG format. The architect makes no representation as to the compatibility of these files with the Contractor's hardware or software.

2. Data contained on these electronic files are part of Cannon Design's, (list additional consultants) instruments of service and shall not be used by the contractor or anyone else receiving data through or from the contractor for any purpose other than as convenience in the preparation of shop and record drawings for the reference project. Any other use or reuse by the Contractor or by others will be at their sole risk and without liability or legal exposure to Cannon Design, (list additional consultants) The Contractor agrees to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against Cannon Design, (list additional consultants) or their officers, directors, employees, agents or sub-consultants, which may arise out of or in connection with their use of the electronic files.

3. These electronic files are not contract documents. Significant difference may arise between these electronic files and corresponding hard copy contract documents due to addenda, change orders or other revisions. Cannon Design, (list additional consultants) make no representation regarding the accuracy or completeness of the electronic files you receive. In the event that a conflict arises between the signed contract documents prepared by Cannon Design, (list additional consultants) and electronic files, the signed contract documents shall govern. The Contractor is responsible for determining if any conflicts exist. By use of these electronic files, Contractor's are not relieved of their duty to comply with the contract documents, including and without limitation, the need to check, confirm and coordinate all dimensions and details, take field measurements, field verify conditions and coordinate the Contractor's work with that of the other contractors for the project.

4. Before release of the drawings, contractors, subcontractors and vendors will be asked to sign a form assenting to these conditions.

END OF SECTION 01720

SECTION 01730 - OPERATION AND MAINTENANCE DATA

1.1 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Shop Drawings, Product Data and Samples: Section 01340.

B. Project Record Documents: Section 01720.

C. Maintenance Manuals for Mechanical and Electrical Work: Divisions 15 and 16.

1.2 DESCRIPTION

A. Manuals:

1. Purpose:

a. Operation and maintenance manuals will be used for training of, and use by, Owner's personnel in operation and maintenance of mechanical and electrical systems and equipment. A separate manual or chapter within a manual shall be prepared for each class of equipment or system.
b. For additional requirements refer to various specification sections.

B. Required:

1. Manuals are required for all systems and equipment.

C. Contents:

1. Each Manual or Chapter Shall Include:

a. Table of contents.
b. Description of system or equipment.
c. Operating sequence and procedures.
d. Safety instructions.
e. Maintenance instructions and requirements, including preventative and corrective maintenance.
f. Spare parts list.

D. Shop Drawings.

1. Each manual shall be accompanied by Shop Drawings of the system or equipment as installed.

E. Copies:

1. Submit 3 copies of Manuals to Architect, for Architect's review.
2. After Architect's review, the Architect will submit 2 copies of Manuals to Owner

for review and acceptance prior to final payment.

F. Instructions of Owner's Personnel

1. Fully instruct Owner's designated operating and maintenance personnel in operating, adjustments and maintenance of all mechanical and electrical systems and equipment as required by respective and pertinent sections, after all final inspection, tests and repairs have been completed.
2. Operating and maintenance manuals shall constitute the basis of instructions. Contents of manual shall be reviewed in full detail, explaining all aspects of operations and maintenance.
3. Prepare and include additional data when need for such data becomes apparent during instruction and training sessions.
4. Training sessions shall be jointly arranged with Owner during Contractor's normal week and daily hours. The Owner shall have the responsibility of scheduling its shift work personnel accordingly.
5. Owner and Contractor shall coordinate and cooperate to keep training sessions to a reasonable minimum.

1.3 INSTRUCTIONS FOR MAINTENANCE OF SURFACES

A. Purpose:

1. To instruct Owner's maintenance personnel in proper methods and materials to use in the proper care of all exposed surfaces.

B. Content:

1. Recommended cleaning materials.
2. Recommended preventative maintenance.
3. Recommended methods and procedures.

C. Copies:

1. Submit 3 copies of Instructions for Maintenance to Architect, for Architect's review.
2. After Architect's review, the Architect will submit 2 copies of Instructions for Maintenance to Owner for review and acceptance prior to final payment.

END OF SECTION 01730

SECTION 01750 - WARRANTIES

1.1 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Project Record Documents: Section 01720.

B. Operation and Maintenance Data: Section 01730.

1.2 DESCRIPTION

A. Warranties Shall Include:

1. One year warranty as required by General Conditions.
2. Extended warranties required by various specification sections.

B. Submit warranties to Architect, for his review.

C. After Architect's review, he will submit warranties to Owner for review and acceptance, prior to final payment.

1.3 WARRANTY

A. The Contractor warrants that the Work and/or equipment provided pursuant to this Contract shall, when used in accordance with its documentation, be able to accurately store, represent and process date/time data (including, but not limited to, calculating, comparing and sequencing), including leap year calculations. Where the Contract requires that specific Work must perform as a package or system, this warranty shall apply to the Work as a system. The Contractor shall, on request, disclose to the Owner the date/time data definitions used by or in the Work.

B. In the event of any breach of this warranty, the Contractor shall restore the Work to the same level of performance as warranted herein, or repair or replace the Work with conforming product so as to minimize interruption to Owner's ongoing business processes, time being of the essence, at Contractor's sole cost and expense. This warranty does not extend to correction of Owner's errors in data entry or data conversion

C. This warranty shall survive beyond termination or expiration of the Contract.

D. Nothing in this warranty shall be construed to limit any rights or remedies otherwise available under this Contract.

E. The Contractor, subcontractors, suppliers, vendors, any of their employees or other authorized entity shall indemnify and hold the Architect, the Engineers, their respective officers, directors, partners, consultants and employees harmless from, and shall pay, all costs, liabilities, damages and expenses (including attorneys fees and expenses) arising out

of any claim related to the failure of the Work and/or equipment to be in compliance with the warranty in Subparagraph 1.3A. This warranty shall survive for the full term of the applicable statute of limitations.

END OF SECTION 01750

SECTION 01810 – BUILDING SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Commissioning.

1. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. This is achieved through a cooperative effort between the design, construction, and commissioning team members. The commissioning process shall encompass and coordinate the functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction phase is intended to achieve the following specific objectives.

a. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted standards and that they receive adequate operational checkout by installing contractors.
b. Verify and document proper performance of equipment and systems.
c. Verify that O&M documentation left on site is organized, complete, and clear.
d. Verify that the Owner's operating personnel are adequately trained.

B. The commissioning process does not take away from or reduce the responsibility of the installing contractors to provide a finished and fully functioning product.

1.2 COORDINATION

A. Commissioning Team

1. The members of the commissioning team consist of the Commissioning agent (Olsson Associates), the Owner's Project Manager, the Owner's Construction Administrator, the Owner's Plant Maintenance Engineer, the General Contractor, the design team, the Mechanical Contractor, the Electrical Contractor, the TAB representative, the Controls Contractor, and any other installing subcontractors or suppliers of equipment. Each member of the commissioning team shall designate a representative who shall attend commissioning team meetings, and be responsible for the execution of commissioning tasks and delivery of commissioning documentation to the Commissioning Agent.

B. Management

1. The Commissioning agent is hired directly by the Owner. The Commissioning agent directs and coordinates the commissioning activities of all commissioning team members and reports to the Owner's Construction Administrator.

C. Scheduling

1. The Commissioning agent will work with the General Contractor, and Owner representative, according to established protocols to schedule the commissioning activities. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

2. The Commissioning agent will provide the initial schedule of primary commissioning events at the commissioning scoping meeting. As construction progresses, more detailed schedules will be developed by the Commissioning Agent.

1.3 COMMISSIONG PROCESS

A. Commissioning Plan

1. A commissioning plan will be issued after contract award to provide more detailed guidance in the execution of the commissioning process. The Commissioning Plan will be updated from time to time to reflect the progress of the project. In the case of a conflict, the Specification*s* will take precedence over the Commissioning Plan except to the extent that a more stringent standard is required by the commissioning plan. In this case, the more stringent standard shall be applied.

B. Commissioning Process

1. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.

a. Commissioning during construction begins with a scoping meeting conducted by the Commissioning agent where the commissioning process is reviewed with the commissioning team members.
b. Additional meetings will be required throughout construction, scheduled by the Commissioning agent with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
c. Equipment documentation, including detailed start-up procedures, shall be submitted to the Commissioning agent by the contractor.
d. The Commissioning agent works with the Contractors in developing startup plans and startup documentation formats, including providing the Contractors with Field Installation Verification (FIV) and Operational

Performance Test (OPT) checklists to be completed, during the startup process.

e. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with prefunctional checklists being completed before functional testing.

f. The Commissioning Agent, with the assistance of the Contractor, executes and documents the Field Installation Verifications (FIV's). The Contractor and his subcontractors and suppliers perform startup and initial checkout in accordance with the Operational Performance Tests (OPT's). The Commissioning agent documents that the checklists and startup were completed according to the approved plans. This may include the Commissioning agent witnessing start-up of all or selected equipment.

g. The Commissioning agent develops specific equipment and system functional performance test procedures (Functional Performance Tests – FPT's). The Contractor will receive copies of the Functional Tests as a courtesy.

h. The procedures are executed by the Commissioning agent. The contractor and the subcontractors will operate all of the equipment under the direction and supervision of the Commissioning agent. The Commissioning agent documents the tests.

i. Items of non-compliance in material, installation or setup are corrected at the Contractor's expense and the systems are re-tested.

j. The Commissioning agent reviews the O&M documentation for completeness.

k. Successful completion of the functional performance tests and specified training activities, and acceptance by the commissioning agent and the owner, is a condition of substantial completion and final acceptance of the project.

l. The Commissioning agent reviews, pre-approves and coordinates the training provided by the Contractor and verifies that all training is completed.

m. Deferred or off season testing is conducted, as specified or required.

1.4 RELATED WORK

A. It is the responsibility of the Contractor to ensure that his subcontractors and suppliers are aware of the commissioning requirements of this project. Certain commissioning activities are specified in other sections of the specification. This section includes additional requirements for the contractor, subcontractors and suppliers. The contractor shall take particular note of the commissioning requirements of this section of the specification. The contractor and all of his subcontractors and Suppliers shall include

sufficient labor, materials, and other costs necessary to execute the commissioning responsibilities outlined in this section of the specification.

1.5 RESPONSIBILITIES

A. Commissioning Agent

1. The primary role of the Commissioning agent is to develop and coordinate the execution of a testing plan, and observe and document that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents.

   a. Coordinates and directs the commissioning activities in a sequential manner using consistent protocols and forms, centralized documentation, regular communications and consultations with all necessary parties, and technical expertise.
   b. Coordinate the commissioning work with the General Contractor and Owner Representative to ensure that commissioning activities are being scheduled into the master schedule.
   c. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
   d. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.
   e. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
   f. Review all RFI's, ASI's, ESI's, and change order requests.
   g. Review TAB Agenda submitted in accordance with NEBB requirements or similar.
   h. Review approved Contractor submittals applicable to systems being commissioned for compliance with commissioning needs.
   i. Write and distribute FIV and OPT tests and checklists.
   j. Develop a start-up and initial systems checkout plan with the Contractor.
   k. Perform site visits, as necessary, to observe component and system installations. Attends selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
   l. Witness all or part of the HVAC piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals.

Notify owners project manager of any deficiencies in results or procedures.

m. Witness all or part of any FIV and OPT procedure execution, sufficient to be confident that proper procedures were followed. Review systems startup and checkout by reviewing start-up reports and by selected site observation.

n. Witness and review all TAB procedures and results.

o. With necessary assistance and review from installing contractors, write the functional performance test procedures for equipment and systems.

p. Analyze any functional performance trend logs and monitoring data to verify performance.

q. Execute and document the functional performance tests. During functional performance testing, all equipment will be operated by the installing contractor. Coordinate retesting as necessary until satisfactory performance is achieved.

r. Maintain a master deficiency and resolution log. Provide the Owner Representative with written progress reports and test results with recommended actions.

s. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.

t. Oversee and review the training of the Owner's operating personnel.

u. Compile and maintain a commissioning record and building systems book(s).

v. Review O&M manuals.

w. Provide a final commissioning report.

B. Contractors

1. Provide all tools or the use of tools to start, checkout and perform functionally test of equipment and systems.
2. Facilitate the coordination of the commissioning work by the Commissioning agent, and ensure that commissioning activities are being scheduled into the master schedule.
3. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the Commissioning agent.
4. In each purchase order, subcontract, or change order, include requirements for submittal data, O&M data, commissioning tasks and training.
5. Ensure that all Subcontractors and Suppliers execute their commissioning responsibilities according to the Contract Documents and schedule.
6. A representative shall attend a commissioning scoping meeting and other necessary meetings scheduled by the Commissioning agent to facilitate the commissioning process.
7. Coordinate the contractual training requirements of the Contractor, Subcontractors, and Suppliers.

8. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

C. Equipment Suppliers

1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
2. Assist in equipment testing per agreements with Subs.
3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor.
4. Provide information requested by Commissioning agent regarding equipment sequence of operation and testing procedures.
5. Review test procedures for equipment installed by factory representatives.

1.6 SYSTEMS TO BE COMMISSIONED

A. The following systems will be commissioned in this project.

1. Chilled Water Plant

a. Verify that the appropriate equipment and systems have been installed. Verify performance of the chilled water plant through a combination of verification of the testing and balancing work and performance testing of the chillers cooling towers, pumps, etc. Document all testing required by the specifications. Coordinate all training activities.

2. Temperature Control System

a. Work with the installing contractor to develop appropriate system check out and documentation methods for the building DDC system controls for the installed systems. Develop performance stability testing to simulate varying building loads and establish the ability of the system to respond appropriately to upset conditions. Document all testing required by the specifications. Coordinate all training activities.

3. Electrical Systems

a. Verify suitable completion of installation and startup of all electrical systems and perform operational testing to establish the ability of the system to deliver appropriate capacity and stability in transient operating conditions. Document all testing required by the specifications. Coordinate all training activities.

4. Review O&M Manuals

   a. Review and comment on Operations and Maintenance Manuals prepared by the project contractor. Provide supplemental system description information for inclusion in manuals.

5. Review Training Agendas

   a. Review and comment on Training Agendas prepared by the project contractors, subcontractors and suppliers. Provide assistance in organizing and effective training program.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup and initial checkout shall be provided by the contractor for the equipment being tested, except for equipment specific to and used by the Commissioning Agent in executing their commissioning responsibilities.

B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment or systems, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site.

C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 MEETINGS

A. Scoping Meeting. At the direction of the Owner Representative, the Commissioning agent will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Meeting minutes will be distributed to all parties by the Commissioning agent.

B. Miscellaneous Meetings. Other meetings will be planned and conducted by the Commissioning agent as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with the Contractor.

3.2 REPORTING

A. The Commissioning agent will provide regular reports to the Owner Representative as construction and commissioning progresses.

B. The Commissioning agent will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes.

3.3 SUBMITTALS

A. The Contractor will provide submittal documentation to the Commissioning Agent to facilitate the commissioning work. The Contractor in their O&M manuals will include all documentation provided to the Commissioning Agent.

B. The Commissioning agent will review submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures.

C. These submittals to the Commissioning agent do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the Commissioning agent will review them.

3.4 START-UP, FIV and OPT CHECKLISTS AND INITIAL CHECKOUT

A. The following procedures apply to all equipment to be commissioned.

B. General. FIV and OPT checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. The prefunctional testing (FIV/OPT's) for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

C. Start-up and Initial Checkout Plan. The Commissioning agent may assist the commissioning team members responsible for startup of any equipment in developing detailed start-up plans for all equipment. The primary role of the Commissioning agent in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for startup are identified in the commissioning scoping meeting and in the checklist forms.

1. These checklists and tests are provided by the Commissioning agent to the

Contractor. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form may have more than one trade responsible for its execution.

2. The subcontractor responsible for the purchase of the equipment develops the full start-up plan by combining (or adding to) the Commissioning agent's checklists with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.

3. The subcontractor submits the full startup plan to the Commissioning agent for review and approval.

4. The Commissioning agent reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.

5. The full start-up procedures and the approval form may be provided to the Owner Representative for review and approval.

D. Execution of FIV/OPT Checklists and Startup.

1. Prior to startup, the Contractor and vendors schedule startup and checkout with the Owner Representative, and the Commissioning agent. The performance of the startup and checkout are directed and executed by the Contractor or vendor.

2. The Commissioning Agent shall, in cooperation with the Contractor, execute the FIV checklists and provide a list of commissioning issues and deficiencies for correction by the Contractor.

3. The Commissioning agent shall observe, at minimum, the OPT procedures for each piece of primary equipment.

4. The Contractor and vendors shall execute, in the presence of the Commissioning Agent (unless specifically notified otherwise), startup procedures and provide the Commissioning agent with a signed and dated copy of the completed start-up. The Commissioning Agent will countersign checklists executed in his presence.

5. Upon completion and acceptance of the start-up and checkout procedures, the Commissioning Agent will execute and document the Functional Performance Tests.

E. Deficiencies, Non-Conformance and Approval in Checklists and Startup.

1. The Contractor shall clearly list any outstanding items of the initial start-up and checkout procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the Commissioning agent within two days of test completion.

2. The Commissioning agent reviews the report and submits either a non-compliance report or an approval form to the Contractor and Owner Representative. The Commissioning agent shall work with the Contractor, Subcontractors and vendors to correct and retest deficiencies or uncompleted items. The installing Contractor shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Commissioning agent as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the Commissioning agent recommends approval of the execution of the checklists and startup of each system to the Construction Administrator using a standard form.

3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in backcharges to the responsible party.

3.5 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope.

1. The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

2. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.

B. Development of Test Procedures.

1. Before test procedures are written, the Commissioning agent shall obtain all requested documentation and a current list of change orders affecting equipment

or systems, including an updated points list, program code, control sequences and parameters. Using the testing parameters and requirements in specifications, the Commissioning agent shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Contractor or vendor responsible to assist in the execution of a test, shall provide limited assistance to the Commissioning agent in developing the procedures review (answering questions about equipment, operation, sequences, etc.). Prior to execution, the Commissioning agent shall provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection. The Commissioning agent may submit the tests to the Design Team for review.

2. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.

C. Coordination and Scheduling.

1. The Contractor shall provide sufficient notice to the Commissioning agent regarding their completion schedule for the startup of all equipment and systems. The Commissioning agent will schedule functional tests through the Owner Representative and Contractor. The Commissioning agent shall execute, witness and document the functional testing of all equipment and systems. The Contractor shall operate their equipment.

D. Problem Solving.

1. The Commissioning agent may recommend solutions to problems found. However, the burden of responsibility to solve, correct and retest problems is with the General Contractor, Subs and Design Team.

3.6 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. Documentation.

1. The Commissioning agent shall document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the Owner Representative for review and approval and to the Contractor for review. The Commissioning agent will include the filled out forms in the O&M manuals.

B. Non-Conformance.

1. The Commissioning agent will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the Owner Representative on a standard non-compliance

form.

2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the Commissioning agent. In such cases the deficiency and resolution will be documented on the procedure form.

3. As tests progress and a deficiency is identified, the Commissioning agent will discuss the issue with the executing contractor.

   a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:

      1) The Commissioning agent documents the deficiency and the Sub's response and intentions and they go on to another test or sequence. After the day's work, the Commissioning agent submits the non-compliance reports to the Construction Administrator for signature, if required. A copy is provided to the Sub and Commissioning agent. The Sub corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the Commissioning agent.
      2) The Commissioning agent reschedules the test and the test is repeated.

   b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

      1) The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the Owner Representative and to the Sub representative assumed to be responsible.
      2) Resolutions are made at the lowest management level possible. Final acceptance authority is with the Owner Representative.
      3) The Commissioning agent documents the resolution process.
      4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the Commissioning agent. The Commissioning agent reschedules the test and the test is repeated until satisfactory performance is achieved.

4. Cost of Retesting.

   a. The time for the Commissioning Agent to direct any retesting required because a specific start-up or checkout item, reported to have been successfully completed, but determined during functional testing to be

faulty, will be backcharged to the General Contractor, who may choose to recover costs from the party responsible for executing the faulty start-up and checkout test.

b. The cost for the labor and material required for the Subcontractor to retest a prefunctional or functional test, shall be theirs. If they are not responsible for the deficiency, any cost recovery for retesting costs shall be negotiated with the General Contractor.

c. For a deficiency identified, not related to any prefunctional checklist or start-up fault, the following shall apply: The Commissioning Agent and Owner Representative will direct the retesting of the equipment once at no "charge" to the General Contractor for their time. However, the Commissioning agent's and Owner Representative time for a second retest will be charged to the General Contractor.

5. The Contractor shall respond in writing to the Commissioning agent and Owner Representative at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.

6. The Commissioning agent retains the original non-conformance forms until the end of the project.

7. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.

C. Approval.

1. The Commissioning agent notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the Commissioning agent and by the Owner Representative.

3.7 OPERATION AND MAINTENANCE MANUALS

A. The Commissioning Agent will be responsible for the coordination of the assembly of the Operations and Maintenance Manuals and all related documentation. For each system, the O & M Manuals will include the following:

1. System Description.

a. Operating Conditions
b. Setpoint Parameters

2. Equipment and Systems Installation Data Sheets

3. Operation and Maintenance Data Sheets

4. Standard Operating Procedures

5. Preventative Maintenance Procedures

6. Spare Parts List

B. The General Contractor, and all Subcontractors and Vendors, will be responsible for providing all equipment and systems installation, operation, and maintenance data sheets, warranty information, and all other information normally provided in the O & M manuals to the Commissioning Agent for inclusion in the final assembled manuals in accordance with the specifications.

3.8 TRAINING OF OWNER PERSONNEL

A. The Commissioning agent shall coordinate and schedule the training to be provided by the Contractors and Vendors for commissioned equipment or systems.

B. Each contractor will be responsible for providing the training services specified in the project documentation.

3.9 DEFERRED TESTING

A. Unforeseen Deferred Tests.

1. If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the Owner Representative. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.

C. Seasonal Testing.

1. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) may be completed as part of this contract. The Commissioning Agent shall coordinate, execute, and document this activity. The Contractor, Subcontractor, and Vendors shall assist with the operation of their equipment and correct any deficiencies. Any final adjustments to the O&M manuals and as-builds due to the testing will be made.

END OF SECTION 01810

SECTION 02070 - SELECTIVE DEMOLITION

PART 1 - GENERAL:

RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. Extent of selective demolition work is indicated on drawings.

B. Types of Selective Demolition Work: Demolition requires the selective removal and subsequent offsite disposal of the following:

1. Concrete piers in the existing cooling tower basin as shown.
2. Piping, mechanical and electrical equipment as idicated.
3. Portions of shaft walls to accommodate new doors.
4. Other demolition work as indicated.

C. Portions of building structure indicated on drawings and as required to accommodate new construction.

D. Cutting non-structural concrete floors and masonry walls for underground piping and ducts, and for above grade piping, ducts, and conduit is included with the work of the respective mechanical and electrical Divisions 15 and 16 specification sections.

E. Related work specified elsewhere:

1. Remodeling construction work and patching is included within the respective sections of specifications, including retrieval of materials for re-use and incorporation into remodeling or new construction.
2. Relocation of pipes, conduits, ducts, other mechanical and electrical work are specified by respective trades.

1.3 SUBMITTALS:

A. Schedule: Submit schedule indicating proposed methods and sequence of operations for selective demolition work to Owner's Representative for review and approval prior to commencement of work. Include coordination for shut-off, capping, and continuation of utility services as required, together with details for dust and noise control protection.

B. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.

C. Coordinate with Owner's continuing occupation of portions of existing building, with Owner's partial occupancy of completed new addition, and with Owner's reduced usage during summer months.

D. Drawings: Submit drawings of existing building showing the size and location of openings to be drilled or cut in floors, roof and/or walls to Owner's Representative for review and approval prior to commencement of work.

1.4 JOB CONDITIONS:

A. Occupancy: Owner will be continuously occupying areas of the building immediately adjacent to areas of selective demolition. Conduct selective demolition work in manner that will minimize need for disruption of Owner's normal operations. Provide minimum of 72 hours advance notice to Owner of demolition activities which will severely impact Owner's normal operations.

B. Condition of Structures: Owner assumes no responsibility for actual condition of items or structures to be demolished.

C. Conditions existing at time of commencement of contract will be maintained by Owner insofar as practicable. However, variations within structure may occur by Owner's removal and salvage operations prior to start of selective demolition work.

D. Partial Demolition and Removal: Items indicated to be removed but of salvageable value to Contractor may be removed from structure as work progresses. Transport salvaged items from site as they are removed.

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

F. Owner's Furnishings: The Owner will remove furnishings and other free standing or loose items from the area(s) of the work before the scheduled start of activities related to work of the Contract(s).

G. Protections: Provide temporary barricades and other forms of protection as required to protect Owner's personnel and general public from injury due to selective demolition work.

H. Provide protective measures as required to provide free and safe passage of Owner's personnel and general public to and from occupied portions of building.

I. Erect temporary covered passageways as required by authorities having jurisdiction.

J. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished, and adjacent facilities or work to remain.

K. Protect and support conduits, drains, pipes and wires to remain in use and susceptible to damage by construction activities.

L. Protect from damage existing finish work that is to remain in place and becomes exposed during demolition operations.

M. Protect floors with suitable coverings when necessary.

N. Construct temporary insulated solid dustproof partitions where required to separate areas where noisy or extensive dirt or dust operations are performed. Equip partitions with dustproof doors and security locks if required.

O. Cover in an airtight manner, or with filter media, return air and exhaust grills in the areas in which work occurs to prevent dirt and dust from entering the air conditioning, ventilating systems and exhaust systems.

P. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces, and installation of new construction to insure that no water leakage or damage occurs to structure or interior areas of existing building.

Q. Remove protections at completion of work.

R. Damages: Promptly repair damages caused to adjacent facilities by demolition work at no cost to Owner.

S. Traffic: Conduct selective demolition operations and debris removal in a manner to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

T. Do not close, block or otherwise obstruct streets, walks or other occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

U. Explosives: Use of explosives will not be permitted.

V. Utility Services: Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.

W. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.

X. Environmental Controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply

with governing regulations pertaining to environmental protection.

Y. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

PART 2 - PRODUCTS (Not Applicable).

PART 3 - EXECUTION

3.1 INSPECTION:

A. Prior to commencement of selective demolition work, inspect areas in which work will be performed. Photograph existing conditions such as structure surfaces, equipment or to surrounding properties which could be misconstrued as damage resulting from selective demolition work; file with Owner's Representative prior to starting work.

B. Verify salvageable materials and/or items with Owner's Representative and determine disposition. Tag salvageable items to be reused for identification and coordination purposes.

3.2 PREPARATION:

A. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement or collapse of structures to be demolished and adjacent facilities to remain.

B. Cease operations and notify the Owner's Representative immediately if safety of structure appears to be endangered. Take precautions to support structure until determination is made for continuing operations.

C. Cover and protect furnishings, equipment and fixtures to remain from soiling or damage when demolition work is performed in rooms or areas from which such items have not been removed.

D. Erect and maintain dust-proof partitions and closures as required to prevent spread of dust or fumes to occupied portions of the building.

E. Where selective demolition occurs immediately adjacent to occupied portions of the building, construct dust-proof partitions of minimum 4" studs, 5/8" drywall (joints taped) on occupied side, 1/2" fire-retardant plywood on demolition side, and fill partition cavity with sound-deadening insulation.

F. Provide weatherproof closures for exterior openings resulting from demolition work.

G. Locate, identify, stub off and disconnect utility services that are not indicated to remain.

H. Provide by-pass connections as necessary to maintain continuity of service to occupied areas of building. Provide minimum of 72 hours advance notice to Owner if shut-down of service is necessary during change-over.

3.3 DEMOLITION:

A. Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.

B. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.

C. Locate demolition equipment throughout structure and promptly remove debris to avoid imposing excessive loads on supporting walls, floors or framing.

D. Provide services for effective air and water pollution controls as required by local authorities having jurisdiction.

E. Demolish foundation walls to a depth of not less than 12" below existing ground surface. Demolish and remove below-grade wood or metal construction. Break up below-grade concrete slabs.

F. For interior slabs on grade, use removal methods that will not crack or structurally disturb adjacent slabs or partitions. Use power saw where possible.

G. Completely fill below-grade areas and voids resulting from demolition work. Provide fill consisting of approved earth, gravel or sand, free of trash and debris, stones over 6" diameter, roots or other organic matter.

H. Cutting and Drilling: Saw cut, and/or drill holes in existing floors, walls, partitions and ceilings as indicated on drawings. Perform work with hand or small power tools, except that power-driven impact tools will not be permitted. Holes shall be neatly cut to required sizes.

I. Cutting or drilling columns, girders, beams or other structural elements is not permitted unless complete detail and structural analysis is submitted to the Architect for review and approval prior to commencement of such work.

J. Holes in floor or roof slabs and in exterior walls must be closed with temporary protectives for safety and weather resistance until new construction is ready for installation.

K. If unanticipated mechanical, electrical or structural elements which conflict with intended

function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to Owner's Representative in written, accurate detail. Pending receipt of directive from Owner's Representative rearrange selective demolition schedule as necessary to continue overall job progress without delay.

3.4 DISPOSAL OF DEMOLISHED MATERIALS:

A. Remove debris, rubbish and other materials resulting from demolition operations from building site. Transport and legally dispose of materials off site.

B. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling and protection against exposure or environmental pollution.

C. Burning of removed materials is not permitted on project site.

3.5 CLEAN-UP AND REPAIR:

A. Upon completion of demolition work, remove tools, equipment and demolished materials from site. Remove protections and leave interior areas broom clean.

B. Repair demolition performed in excess of that required. Return structures and surfaces to remain to condition existing prior to commencement of selective demolition work.

C. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.

END OF SECTION 02070

SECTION 02300 - EARTHWORK

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. General: Provide site earthwork in accordance with the Contract Documents.

B. Description of the System: The work includes, but is not limited to, labor and material to complete the following:

1. Excavation and backfill required in conjunction with underground mechanical and electrical utilities, and buried mechanical and electrical appurtenances.
2. Dewatering as necessary to perform all work "in the dry".
3. Disposal of excess and waste materials (including oil contaminated soils).
4. Temporary earth retaining structures as necessary to maintain the integrity of the excavation and prevent settlement of adjoining structures.

C. Related Sections and Information: The following sections or sources of information contain requirements that relate to this section:

1. Division 1 Section "Special Inspections and Testing"
2. Division 2 Section "Selective Demolition"
3. Division 2 Section "Landscape Work"
4. Division 3 Section "Concrete, Reinforcement and Formwork"
5. Division 13 Section “Asbestos Abatement”
6. Divisions 15 and 16 Sections on underground utilities

D. Definitions:

1. Excavation: Removal of material encountered to subgrade elevations indicated and subsequent disposal or reuse of materials removed as directed by the Architect/Engineer.
2. Unclassified excavation: Removal and disposal of all material regardless of character of material and obstructions encountered.

a. Typical of materials classified as rock are boulders 1/2 cu. yd. or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.

3. Unauthorized excavation: Removal of materials beyond indicated subgrade elevations or dimensions without written authorization by the Architect/Engineer. No payment will be made for unauthorized excavation or remedial work required to correct unauthorized excavation.
4. Authorized Additional Excavation: Removal of additional material authorized by the Architect/Engineer based on the determination by the Owner's geotechnical consultant that unsuitable bearing materials are encountered at required subgrade elevations.
5. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular subbase, drainage fill, or topsoil materials.
6. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

1.3 SUBMITTALS

A. Certificate: Before proceeding with the work, submit to the Architect/Engineer one copy of certification in an acceptable form stating that careful examination has been made of the site, existing structures, records of utility lines, records of subsurface explorations and samples, and the Contract Documents.

1.4 QUALITY ASSURANCE

A. Codes and Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the latest editions of the following:

1. State Department of Transportation Standards
2. State and Local Environmental Standards
3. ANSI A10.2 "Safety Code for Building Construction"
4. OSHA "Standards for Excavations" 29 CFR 1926.650.
5. State and Federal Code requirements governing the disposal of waste materials and contaminated soils.

1.5 TESTING

A. Contractor's Quality Control

1. Perform all earthwork using personnel experienced in earthwork operations, in a manner which will not interfere with or delay work of other trades.
2. The Contractor is responsible for all additional observation and testing resulting as a consequence of earthwork:

a. Not in compliance with this specification.
b. Performed with improper supervision.
c. Performed without prior notice, or
d. Performed contrary to standard construction practice.

1.6 PROJECT CONDITIONS

A. General: Examine the site, the drawings, the records of existing utilities and construction to determine all known conditions under which excavations will be made. All site data, are for information only and are not guaranteed to represent all conditions which will be encountered.

1. The records of existing utilities and existing construction (including underground construction) represent all conditions known to the Owner. Other construction, of which no records have been discovered, may be encountered.

B. Existing Utilities

1. Locate existing underground utilities in the area of the Work. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult the Architect/Engineer immediately for directions.
2. Provide adequate protection for aerial or underground utility lines noted to remain.
3. Demolish and dispose of existing underground utilities indicated to be removed and completely fill exposed ends of utilities that will remain with concrete. Coordinate with the utility owners for shut-off of services if lines are active. Immediately notify the Owner if existing utilities contain asbestos before proceeding with remediation and abatement work in that area.
4. Repair damaged utilities to the satisfaction of the utility owner.

C. Protection of Persons and Property

1. Protect existing structures and site features noted to remain against damage from equipment and vehicular traffic as required.
2. Barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
3. Temporary Earth Retaining Structures: Take every precaution to guard against any movement or settlement of existing or new construction, utilities or permanent benchmarks. Slope sides of excavations to comply with local codes. Shore and brace where sloping is not possible because of proximity to adjacent building foundations, space restrictions, or due to the instability of the material excavated. Provide bracing, shoring, sheeting, sheet piling, underpinning or other retaining structures as necessary. Assume responsibility for the safety and support of all such construction, and be responsible for any consequent movement, settlement, damage or injury.
4. Prior to the start of excavation, photograph, record and date the condition of all adjoining properties. Establish benchmarks on each adjacent structure; use a reference datum elevation located sufficiently distant so as to not be affected by excavation operations. During excavation, resurvey the benchmarks weekly and maintain an accurate log of the results. Promptly notify the Architect of any changes in elevation or if any sags or cracks appear.

5. Pumping and Drainage: Control grading to prevent water from running into the excavated areas. Seal roll exposed subgrades to promote surface drainage. Until the Work is completed, remove water that may interfere with the proper performance of the Work or cause ponding on the Owner's or adjacent property.
6. In case of any damage caused in the performance of the Work, repair or remove and replace such damage to the satisfaction of, and without cost to, the Owner. Repair or replace existing roads, walks, and curbs damaged during the project work to new condition, as directed by the Owner.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General Fill:

1. Satisfactory soil materials - defined as those soils complying with ASTM D-2487 "Classification of Soils for Engineering Purposes", soil classification groups GW, GP, GM, SM, SW and SP. Soils must be suitable for placement in relatively thin lifts and compaction to the specified densities.

B. General Fill: Satisfactory soil materials including sand, gravel, friable earth, or clays of low plasticity, free of organic material, cinders, frozen material, trash, masonry, or rubble, and free of stones having a maximum dimension greater than 4 inches. Soils must be suitable for placement in relatively thin lifts and compaction to the specified densities.

C. Granular Fill/Sand: Comply with ASTM C-33. Clean, well-graded, free draining natural or crushed sand, natural or crushed stone or crushed slag free from clay and conforming to the following gradation requirements.

Sieve Size	Percent Passing
3/8"	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	1-10
No. 200	0-3

D. Fine Granular Fill: Clean, fine graded material from rock crushing operations (manufactured sand) free of contamination from clay, silt, or organic material. Uniform distribution of particles from #4 sieve to #200 sieve, with 10 to 30 percent passing the #100

sieve.

E. Gravel/Stone: Comply with ASTM C-33. Clean, hard, sound, durable, uniform in quality and free of any detrimental quantity of deleterious substances.

Sieve size	Percent Passing
1-1/2"	100
1"	90-100
1/2"	0-15

F. Non-Frost Susceptible Material: Well graded granular material with a maximum diameter of 2 inches and with less than 7% passing a #200 sieve.

G. The Contractor may propose alternate materials with similar engineering properties for consideration by the Architect/Engineer. Such materials will be considered only where substitution results in a credit to the Owner. Crushed concrete is expressly prohibited for use as fill or backfill material without expressed written permission of Engineer.

H. Utilization of Excavated Materials: Use all suitable materials removed from excavations including material from foundation excavations insofar as practicable in the formation of fills and for backfilling. Suitability of excavated materials for use as fills will be determined by the Owner's geotechnical consultant based on laboratory testing and performance in the field during compaction. Separate unsuitable material from material suitable for fill. Separate material that is suitable for use as fill under slabs and paving and for backfill from material which is only suitable for general grading.

2.2 NON-SOIL MATERIALS:

A. Non-Woven Geotextile - Subject to compliance with project requirements, provide one of the following products:

1. Terratex SD
2. Exxon GTF 130D
3. Mirafi 140NC
4. Amoco 4545
5. Typar 3401
6. Other approved equal

B. Lean Concrete - Minimum f'c = 2000 psi; minimum cement content 150 lb./cy.

C. Flowable fill - Minimum f'c = 500 psi; minimum unit weight of 150 lb./cf.

PART 3 - EXECUTION

3.1 GENERAL

A. Excavation is unclassified.

B. Excavate to the lines and elevations required. Side forms are required for all concrete work including footings, grade beams, caps, and walls, unless otherwise indicated. Where forms are required, make excavations sufficiently large to permit placing and removal of forms, installation of waterproofing, dampproofing or utilities and for inspection thereof. Do not excavate below the elevations required without written authorization of the Architect/Engineer. Where omission of forms is requested by the Contractor and accepted by the Architect/Engineer, provide additional concrete as required at no additional cost to the Owner.

C. Under footings, foundation bases, or retaining walls, fill unauthorized excavations by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill or properly compacted crushed stone may be used to bring elevations to proper position when acceptable to Owner's geotechnical consultant.

D. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by the Architect/Engineer based on the recommendation of the Owner's geotechnical consultant.

E. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

3.2 EXCAVATION FOR SLABS SUPPORTED ON GRADE:

A. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10', and extend a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for observation and testing.

1. Take care in excavating not to disturb bottom of excavation. Excavate by hand, if necessary, to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.

B. Subgrades of all soil footings shall be level and clean, free of loose rock, dirt, debris, standing water, frost, or ice prior to acceptance for casting concrete.

C. Excavate for slabs supported on grade to the subgrades indicated. Remove any unsuitable material within 12 inches of the design subgrade and replace with suitable compacted fill. Undercut any areas that contain uncontrolled fill to a depth of at least 2 feet below the design subgrade. Proofroll the excavated area with a 10 ton static roller, and further undercut any areas which do not stabilize. Replace all over-excavated material with suitable compacted fill.

3.3 EXCAVATION FOR PAVED AREAS

A. Excavate to the subgrade required to accept the full pavement section plus specified base course from the required finished grade. Fill and compact any over-excavation more than 1/2” below the design subgrade elevation at no additional cost to the Owner.

B. Grade the subgrade to provide uniform slopes, free of mounds, ridges, and depressions which may collect water or impede surface drainage. Create smooth curves through high and low points. Where subgrades contain unsuitable and/or frost susceptible material, perform additional excavation to remove it. Replace all additional excavation with suitable compacted fill.

3.4 EXCAVATION FOR TRENCHES

A. Dig trenches to the uniform width required for the particular item to be installed, sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of pipe or conduit.

B. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finished grade to avoid freeze-ups.

C. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of pipe.

D. For pipes or conduit 5" or less in nominal size and for flat-bottomed multiple-duct conduit units, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.

E. Except as otherwise indicated, excavate for exterior water-bearing piping (water, steam, condensate, drainage) to ensure top of piping is not less than 4'-0" below finished grade.

F. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.

G. Use care in backfilling to avoid damage or displacement of pipe system.

H. Backfill trenches with concrete where trench excavations pass within 18" of column or wall footings, which are carried below bottom of such footings, or which pass under wall footings. Wrap pipe with compressible material for length of encasement. Place concrete up to level of bottom of adjacent footing.

1. Concrete is specified in Division 3.

I. For piping or conduit less than 2'-6" below surface of roadways, provide minimum 4" thick

concrete base slab support. After installation and testing of piping or conduit, provide minimum 4" thick encasement (sides and top) of concrete prior to backfilling or placement of roadway subbase.

3.5 EXCAVATION FOR NON-PAVED AREAS:

A. Excavate to the lines and grades indicated. The subgrade for non-paved areas shall be graded to a tolerance of +/- 1". Grade to provide uniform slopes, free of mounds, ridges and depressions that may collect water or impede surface drainage. Create smooth curves at high and low points.

3.6 COLD WEATHER PROTECTION:

A. Protect the bottom of excavations against freezing when atmospheric temperature is less than 35 degrees F.

3.7 PROTECTION OF SUBGRADES

A. Take precautions during final stages of excavation to preserve the undisturbed state of the natural soil at the proposed subgrade level. Such precautions may include, but not be limited to, keeping equipment off the final subgrade during the last several feet of excavation, and using excavating buckets without teeth.

B. Protect the natural subgrades once final subgrade level has been reached. Carefully grade to prevent ponding of water, install temporary sumps, and apply an initial protective lift of compacted crusher run stone or gravel, and/or a lean concrete "mud" mat, as applicable.

C. Failure to properly excavate and protect approved subgrades, resulting in additional excavation and approved backfill to attain a suitable subgrade in accordance with these Specifications, will be at the expense of the Contractor.

3.8 COMPACTION EQUIPMENT:

A. General: Prior to placing any fill, demonstrate to the Owner's geotechnical consultant that the compaction method or methods, and the equipment that is proposed for use, will provide the degrees of compaction hereinafter specified. It is the responsibility of the Contractor to select, furnish, and properly maintain equipment which will compact the subgrade and fill uniformly to the required densities.

B. Do not excavate to final subgrade or place fill until approved compaction equipment is on the site and in working condition.

C. Maintain a smooth steel wheel roller with a rated capacity of 10 tons at the site at all times during earthwork operations. Use the roller to seal the surface of the fill at the close of

each working day, and at other times when recommended by the Owner's geotechnical consultant, to prevent infiltration of precipitation and surface water into the fill material.

3.9 FILL AND BACKFILL

A. Use of Materials

1. General Fill

   a. Fill and backfill exterior sides of site structures to subgrade where no slab on grade, no pavement, and no foundation drains occur.
   b. Site fill where no pavement occurs.
   c. Fill and backfill to subgrade at site trenches where no slab on grade or pavement occurs.
   d. Fill and backfill to subgrade where demolition is required and no building or pavement occurs. In addition to earth fill, the use of block, brick, stone and concrete not exceeding 1/4 cubic feet per unit is permitted if acceptable to Owner's geotechnical consultant and if kept a minimum of 12" below finished subgrade and mixed with mineral soil fill during placement.
   e. Fill and backfill in areas not otherwise specified.

2. Granular Fill/Sand

   a. Bedding as detailed for mechanical and electrical utility trenches.
   b. Backfill as required and detailed for underground tanks.
   c. Backfill above foundation drains as detailed.

3. Fine Granular Fill

   a. Overlay course on slab sub-base material.
   b. Fill over vapor barrier beneath slab on grade.

4. Gravel/Stone

   a. Backfill as required and detailed for underground tanks. Use only well rounded stone, not crushed stone.
   b. Underslab porous base material as detailed on Contract Drawings. Fine granular overlay may be required.
   c. Backfill at site trenches where pavement occurs.
   d. Backfill around sub-soil drainage lines enclosed within an approved non-woven geotextile installed in accordance with manufacturer's written instructions.

5. Non-frost susceptible material

   a. Use under paved areas within 3 feet (elevation) of finished pavement grade.

6. Flowable Fill

   a. Use in underground piping trenches as shown.

B. Preparation

1. Ground Surface Preparation: Remove vegetation, topsoil, debris, obstructions and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
2. When the existing ground surface is unstable when proofrolled, break up the ground surface, pulverize, moisture-condition to near optimum moisture content, and compact to the required depth and percentage of maximum density. Subgrades which cannot be stabilized in this manner must be undercut and replaced with controlled fill materials.

C. Placement of Fill Materials

1. Backfill excavations as promptly as work permits, but not until completion of the following:
   a. Areas have been examined by the Owner's geotechnical consultant and recommended for approval.
   b. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
   c. Observation, testing, approval and recording of locations of underground utilities.
   d. Removal of concrete formwork.
   e. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
   f. Removal of trash and debris.
   g. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
2. Frost - Do not place any fill material when either the fill material or the previous lift or subgrade on which it is to be placed is frozen. In the event that the subgrade or any fill becomes frozen, scarify it to break up all frozen material, apply heat directly with propane burners to thaw the materials and recompact or remove it before the next lift is placed. Remove or recompact any soft areas resulting from frost before new fill is placed over the area.
3. Place backfill and fill materials in layers not more than 8" in loose depth for cohesive materials and 12" in loose depth for non-cohesive materials compacted by heavy compaction equipment, and not more than 4" in loose depth for cohesive materials and 6" in loose depth for non-cohesive material compacted by hand-operated tampers. Testing by the Owner's geotechnical consultant will be used to evaluate whether the lift thickness is appropriate for the equipment being used.

4. Place each layer of fill at a moisture content within +/- 2 percent of the optimum moisture content as determined by ASTM-D-1557. Before compaction, moisten or aerate each layer as necessary to provide near optimum moisture content.
5. Place backfill and fill materials evenly adjacent to structures, piping or conduit to required elevations. Take care to prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping or conduit to approximately the same elevation in each lift.
6. Use extreme caution in the proximity of existing foundation walls and buildings. Use a manually operated portable compactor adjacent to foundation walls. The use of large self propelled equipment within 8' or a horizontal distance equal to the height of the wall, whichever is greater, is prohibited.
7. Place and compact underslab fill and backfill before installation of underfloor mechanical lines. Install underslab porous base material after underslab mechanical lines have been installed, backfilled, and compacted.
8. Where the depth of general fill or backfill will be greater than or equal to 36 inches, allow for a 30 day settlement period. At the end of this period or later, condition the soil to near optimum moisture content and re-densify the top 6 inch layer to the specified density.
9. Avoid routing of heavy construction equipment including loaded trucks over finished subgrade areas or compacted fill areas to avoid the adverse effects under the load of such equipment. Heavy equipment is expressly prohibited from approaching within 8 feet of backfilled foundation walls. The Contractor is responsible for the repair and/or replacement of any areas adversely affected by construction activities.

3.10 COMPACTION - DENSITY REQUIREMENTS

A. Compact soil to not less than the following percentages of maximum density at optimum moisture content for soils which exhibit a well-defined moisture density relationship determined in accordance with ASTM D-1557, and not less than the following percentages of relative density, determined in accordance with ASTM D-4253 and ASTM D-4254 for soils which will not exhibit a well-defined moisture-density relationship. Perform all compaction in the presence of the Owner's geotechnical consultant.

B. Compaction Beneath other Structural Members, Building Slabs Supported on Grade and Against Foundation Walls.

1. Compact the subgrade and each layer of fill or backfill to at least the following densities:

   a. Under building slabs supported on grade - 95% maximum dry density or 80% relative density.
   b. Against foundation walls - 92% maximum dry density or 75% relative density.

C. Compaction for Paved Areas - Compact the subgrade and each layer of fill or backfill to at least the following densities:

1. 95% maximum dry density or 80% relative density.

D. Compaction for Lawns, Unpaved Areas and for Walkways - Compact the top 6" of subgrade and each layer of fill or backfill to at least the following densities:

1. 90% maximum dry density or 70% relative density.

E. Remove and recompact any lift or portion thereof which is not compacted in accordance with the Specifications. Perform work to the satisfaction of the Owner's geotechnical consultant. Allow each lift to be tested and approved before placing subsequent lifts.

3.11 GRADING

A. General: Uniformly grade the areas within the limits of this section, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between such points and existing finished grades. Provide a smooth transition between abrupt changes in slope.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding.

C. Grading Surface of Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of +0"\-1" measured from design elevation of bottom of slab for both subgrade and underlsab porous base material.

D. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 0.25 inches of indicated grades.

E. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.12 MAINTENANCE:

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

B. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

C. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality and condition of surface of finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.13 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL

A. Remove from site and dispose of excavated materials unsuitable for fill and/or backfill.

3.14 CLEANING

A. Upon completion of earthwork operations, clean areas within contract limits, remove tools and equipment. Provide site clear, clean, free of debris, and suitable for subsequent construction operations.

END OF SECTION 02300

SECTION 02931 **-** SODDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Furnish all labor, materials and equipment necessary to complete all sodded lawns as shown and specified. Includes all areas within Contract limits where buildings and paving do not occur, unless indicated otherwise.

1.2 SUMMARY

A. Areas of anticipated replacement lawns are shown on drawings as limits of disturbance. Contractor is responsible for documenting existing lawn areas and plants within the limits of disturbance.

B. Types of work required include following:

1. Fine grading and preparing of lawn areas.
2. Furnishing and applying new topsoil.
3. Furnishing and applying soil amendments.
4. Furnishing and applying fertilizers.
5. Sodding new lawn areas.
6. Reconditioning existing lawn areas.
7. Replanting unsatisfactory or damaged lawns.

C. Refer to earthwork sections in this Division for requirements of general excavation, filling, and grading in areas to receive lawns and grasses.

D. Topsoil for lawns is not available at site. Furnish topsoil as specified under "Materials."

1.3 SUBMITTALS

1. Delivery Storage and Handling: Deliver seed and fertilizer materials in original unopened containers, showing weight, analysis, and name of manufacturer. Store in a manner to prevent wetting and deterioration.

B. Topsoil Analysis Report: Submit soil analysis report for proposed new topsoil.

1. Before delivery of topsoil, furnish Architect a written statement giving location of properties from which topsoil is to be obtained, names and addresses of owners,

depth to be stripped, and crops grown during the past 2 years.

C. Sod Analysis: Notify Architect of sod source, including name and telephone number of supplier, and seed mix of sod.

1.4 PROJECT CONDITIONS

A. Protect existing utilities, paving, and other facilities from damage caused by sodding operations.

B. Perform sodding work only after planting and other work affecting ground surface has been completed.

C. Restrict traffic from lawn areas until sod is established. Erect signs and barriers as required.

D. Provide hose and lawn watering equipment as required.

1.5 SPECIAL PROJECT WARRANTY

A. Warranty lawns through specified maintenance period and until final acceptance.

PART 2 - PRODUCTS

2.1 NEW TOPSOIL

A. Provide topsoil that is fertile, friable, naturally loamy, surface soil; reasonably free of subsoil, clay lumps, brush weeds, and other litter; and free of roots, stumps, stones larger than 1 inch in any dimension, and other extraneous or toxic matter harmful to plant growth.

B. Obtain topsoil from local sources or from areas having similar soil characteristics to that found at site of work. Obtain topsoil from naturally well-drained sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2.2 SOIL AMENDMENTS

A. Lime: Natural limestone containing at least 85 percent calcium carbonate ground to such fineness that at least 90 percent passes a 10-mesh sieve and at least 50 percent passes a 100-mesh sieve.

1. Provide lime in form of dolomitic limestone.

B. Peat Humus: Finely divided or granular texture and with pH of 6.0 to 7.5 composed of moss peat (other than sphagnum), or peat humus, or reed-sedge peat.

2.3 SULFUR OR IRON SULFATE

A. In dry powder form.

2.4 FERTILIZER

A. Bonemeal: Commercial raw bonemeal, finely ground and with minimum analysis of 4 percent nitrogen and 20 percent phosphoric acid.

B. Commercial Fertilizer:

1. Starter fertilizer containing 20% nitrogen, 26% phosphoric acid, and 6% potash by weight, or similar approved composition.

2.5 GRASS MATERIALS

A. Sod: Provide machine-cut, strongly rooted, certified turfgrass sod, at least 2 years old and free of weeds and undesirable native grasses. Provide sod capable of vigorous growth and development when planted (variable, not dormant) and complying with the following requirements:

1. Type: Kentucky Bluegrass (Poa pratensis).

B. Sod Pad Size: Uniform thickness of 5/8 inch, plus or minus 1/4 inch, measured at time of cutting and excluding top growth and thatch. Provide in supplier's standard size of uniform length and width with maximum 5 percent allowable deviation in either length or width. Broken or torn pads or pads with uneven ends are not acceptable.

C. Sod Strength: Provide sod pads capable of supporting their own weight and retaining size and shape when supplier's standard size pad is suspended vertically from a firm grasp on upper 10 percent of the pad.

2.6 MOWING STRIP MATERIALS

A. Steel Edging

1. Flexible steel sections 3/16" thick x 4" high x 16' long. Brackets for stakes at maximum 30" intervals. Tapered steel stakes, minimum length 16". All materials to have two coats of green rust-inhibiting paint.

B. Weed Barrier

1. Mirafi 140S fabric as manufactured by Celanese Fibers Marketing company or approved equal. Minimum weight: 140 G/Mz.

C. Aggregate

1. Natural rounded mixed color river gravel. Majority of gravel to be 1/2" size with a minor sizing range of 3/8" minimum to 5/8" maximum. Similar to approved sample.

2. Crushed brick with minor sizing range of 1/8" size to 5/8" maximum. Color to be approved by Architect.

PART 3 - EXECUTION

3.1 SOIL PREPARATION

A. Limit preparation to areas that will be sodded in the immediate future.

B. Loosen subgrade to a minimum depth of 4 inches. Remove stones bigger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter.

C. Clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to toxic to plant growth.

D. Mix soil amendments and fertilizers with topsoil at rates specified. Topsoil from on-site and off-site sources shall have an acidity range of PH 5.0 to 7.0 and shall contain not less than 5 percent organic matter as determined by loss of ignition of moisture-free samples dried at 100 degrees C. Delay mixing of fertilizer if planting will not follow placing of topsoil mixture within a few days. Either mix soil before spreading or apply soil amendments on surface of spread topsoil and mix thoroughly into top 4 inches of topsoil before planting.

1. Where topsoil pH is below 5.0, limestone shall be added at a rate of 2-1/2 lbs. per cu. yd. of topsoil to raise the pH value one full point.
2. Where topsoil pH is above 7.0, sulfur or iron sulfate shall be added at a rate of 2-1.6 lbs. or 3.2 lbs respectively per cu. yd. of topsoil to lower the pH value one and one-half points.
3. Mix lime with dry soil before mixing in fertilizer.

E. Spread topsoil mixture to depth required to meet thickness, grades, and elevations shown, after light rolling and natural settlement. Do not spread if material or subgrade is frozen.

1. Place approximately 1/2 of total amount of topsoil mixture required. Work into top of loosened subgrade to create a transition layer, and then place remainder of topsoil mixture.
2. Allow for sod thickness in areas to be sodded.

F. Grade sod areas to a smooth, even surface with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas

that can be planted within immediately future. Remote trash, debris, stones larger than 1 inch diameter, and other objects that may interfere with planting or maintenance operations.

G. Tops and bottoms of slopes shall be carefully rounded off in each transition curve. The border of the area of ground disturbed shall be merged with surrounding surface by compacting or other means, to permit water run-off and to present a uniform slope.

H. Clean and clear all obstructions from drainage structures ditches, swales, as may be necessary to provide a clean, open, free running passageway for all surface water.

I. Moisten prepared sod areas before planting if soil is dry. Water thoroughly and allow surface to dry off before sodding lawns. Do not create muddy soil.

J. Restore prepared areas to specified condition if eroded or otherwise disturbed after fine grading and before sodding.

3.2 SODDING NEW LAWNS

A. Lay sod within 24 hours of stripping. Do not lay dormant sod or if ground is frozen.

B. Lay sod to form solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to subgrade or sod. Tamp or roll lightly to ensure contact with subgrade. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering adjacent grass.

C. Water sod with fine spray immediately after planting. During first week, water daily or more frequency as necessary to maintain moist soil to depth of 4 inches.

3.3 RECONDITIONING LAWNS

A. Recondition existing lawn areas damaged by Contractor's operations including storage of materials or equipment and movement of vehicles. Also recondition lawn areas where settlement or washouts occur or where minor regrading is required.

1. Recondition other existing lawn areas where indicated.

B. Provide fertilizer, seed and soil amendments as specified for new lawns and as required to provide satisfactorily reconditioned lawn. Provide new planting soil as required to fill low spots and meet new finish grades.

C. Cultivate bare and compacted areas thoroughly to provide a good, deep planting bed.

D. Remove diseased or unsatisfactory lawn areas; do not bury into soil. Remote topsoil containing foreign materials resulting from Contractor's operations including oil drippings,

stone, gravel, and other construction materials; replace with new topsoil.

E. Where substantial lawn remains (but is thin), mow, rake aerate if compacted, fill low spots, remove humps, cultivate soil, fertilize, and seed. Remove weeds before seeding. If weeds are extensive, apply selective chemical week killers as required. Apply a seedbed mulch, if required, to maintain most condition.

F. Water newly planted areas and keep moist until new grass is established.

3.4 PROTECTION

A. Erect barricades and warning signs as required to protect newly sodded areas from traffic. Maintain barricades throughout maintenance period until lawn is established.

3.5 MAINTENANCE

A. Begin maintenance of lawns immediately after each area is planted and continue for the periods required to establish acceptable lawns, but no less than the following:

1. Sodded lawns, at least 30 days after date of substantial completion.

B. Maintenance of sodded lawn areas shall include watering, spot weeding, fertilizing, disease and insect pest control, mowing, resodding, application of herbicides, fungicides and insecticides until a full uniform stand off grass, free of weeds, undesirable grass species, disease and insects is achieved and accepted by the Architect.

C. Mow lawns as soon as there is enough top growth to cut with mower set at specified height for principal species planted. Repeat mowing as required to maintain specified height. Remove no more than 40 percent of grass leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Time initial and subsequent mowings to maintain following grass height:

1. Mow grass from 1-1/2 inches to 2 inches high. Do not mow to less than 1-1/2 inches. Minimum of 3 mowings prior to acceptance.
2. Pick-up of grass clippings shall be required during or immediately after each mowing, if clippings are an average of 1 inch or longer in length.

D. Apply weed and feed fertilizer application after first mowing and when grass is dry.

1. Use fertilizer that will provide at least 1. lb. of actual nitrogen per 1,000 sq. ft. of lawn area.

E. Contractor to repair rework and resod all areas that have washed out, are eroded or do not catch.

F. Contractor will provide such barricades, temporary fencing, signs or policing as may be

necessary to eliminate or minimize damage to lawn. Contractor is responsible for all damage that occurs unless damage is beyond Contractor's control. Should damage occur beyond Contractor's control, Contractor will submit request for change order and provide reasonable proof of damage.

3.6 MOWING STRIP

A. Set steel edging true to line and anchor with stakes on gravel side of edging. Use 3" radius on all corners, except where 90 degree bends are required. For all 90 degree bends, score inside face of edging with hacksaw to form an unbroken 90 degree bend.

B. Top of edging shall be 3/4" above grade on either side of edging, unless detailed otherwise.

C. Place weed barrier over subgrade, lapping a minimum of 6". No topsoil to be placed under weed barrier.

D. Place gravel over weed barrier to indicated depth, taking care not to puncture barrier material.

3.7 ACCEPTANCE

A. When work is substantially completed, including maintenance, Architect will, upon written request and 10 days notification, make an inspection to determine acceptability.

B. Replant rejected work and continue specified maintenance until reinspected by Architect and found to be acceptable.

C. Upon acceptance, the Owner will assume lawn maintenance.

D. Sodded lawns will be acceptable provided requirements, including maintenance, have been met and healthy, well-rooted, even-colored, viable lawn is established, free of weeds, open joints, bare areas, and surface irregularities.

3.8 CLEANUP

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto surface of roads, walks, or other paved areas.

B. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris and equipment. Repair damage resulting from sodding operations.

END OF SECTION 02931

SECTION 02950 - LANDSCAPE WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Related Sections:

1. Division 2 Section "Earthwork"
2. Division 2 Section "Sodding"

1.2 SUMMARY

A. This Section includes provisions for the replacement of landscaping in the trench excavation area to match existing landscape items disturbed by the work of this Project.:

1. Shrubs
2. Ground cover
3. Soil amendments, mixing and placing

1.3 QUALITY ASSURANCE

A. Subcontract landscape work to a single firm specializing in landscape work.

1.4 SOURCE QUALITY CONTROL

A. General: Ship landscape materials with certificates of inspection required by governing authorities. Comply with regulations applicable to landscape materials.

B. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.

C. Shrubs: Provide shrubs of quantity, size, genus, species, and variety to match existing.

D. Label at least one tree and one shrub of each variety with a securely attached waterproof tag bearing legible designation of botanical and common name.

1. Where formal arrangements or consecutive order of trees or shrubs are shown, select stock for uniform height and spread, and label with number to assure symmetry in planting.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

B. Deliver fertilizer to site in manufacturer's standard unopened containers bearing manufacturer's name, product name and guaranteed statement analysis. Fertilizer shall not have been exposed to weather prior to delivery, shall be completely protected after delivery, and shall not be stored in direct contact with ground.

C. Deliver other packaged materials to the site in manufacturer's standard unopened containers labeled to show ingredients and analysis and stored in a protected location.

D. Shrubs: Provide freshly dug shrubs. Do not prune prior to delivery. Do not bend or bind-tie shrubs in such manner as to damage bark, break branches, or destroy natural shape. Provide protective covering during delivery. Do not drop balled and burlapped stock during delivery.

E. Deliver shrubs after preparations for planting have been completed and plant immediately. If planting is delayed more than 6 hours after delivery, set shrubs in shade, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap or other acceptable means of retaining moisture.

F. Do not remove container-grown stock from containers until planting time.

1.6 JOB CONDITIONS

A. Utilities: Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Architect before planting.

C. Do not damage installed materials.

D. Planting shall be done during normal planting seasons for each type of plant, and only during periods which are suitable, as judged from the standpoint of weather conditions and local accepted practices, and which are approved.

E. Plant shrubs and ground covers after final grades are established.

F. Observe precautionary measures to protect existing paved areas, against damage during the

planting operation.

1.7 SEQUENCING AND SCHEDULING

A. Planting Time: Proceed with, and complete landscape work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required.

1. Plant or install materials during normal planting seasons for each type of plant material required.
2. Correlate planting with specified maintenance periods to provide maintenance from date of substantial completion.

B. Coordination with Lawns: Plant trees and shrubs after final grades are established and prior to planting of lawns. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

C. Warranty shrubs through specified maintenance period, and until final acceptance.

D. Warranty shrubs for a period of one year after date of completion and initial acceptance against defects including death and unsatisfactory growth, except for defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond Landscape Installer's control.

E. Remove and replace shrubs or other plants found to be dead or in unhealthy condition during warranty period. Make replacements during growth season following end of warranty period. Replace trees and shrubs which are in doubtful condition at end of warranty period; unless, in opinion of Architect, it is advisable to extend warranty period for a full growing season.

F. Where it is determined by the Architect that wildlife or storm damage has occurred tot he trees or shrubs, the Contractor shall not be held responsible for the replacement of plant material damaged due to these conditions except as noted in Part 3 of these Specifications.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Topsoil for landscape work is not available at site and must be furnished as specified.

B. Provide new topsoil that is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 1 inch in any dimension, and other extraneous of toxic matter harmful to plant growth.

1. Obtain topsoil from local sources or from areas having similar soil characteristics

to that found at project site. Obtain topsoil only from naturally, well-drained sites where topsoil occurs in a depth of not less than 4 inches. Do not obtain from bogs or marshes.

C. Topsoil shall meet the following requirements:

1. Soil acidity range: ph 5.5 to ph 7.0 inclusive.
2. Soil salinity by electrical-conductivity measurements shall not exceed three million per centimeter at 25 degree C., as determined by the saturated soil paste method described in USDA Circular No. 982.
3. Soil fertility shall rate "high" in natural nutrients based on the coordinated ratings in pounds per acre as established by the National Soil and Fertilizer Research Committee.
4. Soil texture shall be a classification that will sustain normal healthy growth and development of the plants and lawns, and shall consist of 10-30 percent clay, 10-60 percent sand, and 30-70 percent silt as determined by the buoyoucous hydrometer or the decantation method.
5. Should test sand analysis indicate that soil proposed for use is deficient in any of the above requirements, a system of ameliorating may be proposed for approval. Any system proposed shall provide for an acidity range of ph 6.1 to ph 6.5 inclusive.

2.2 PLANT MATERIALS

A. Quality: Provide shrubs, and other plants of size, genus, species, and variety to match existing.

B. Plants shall be sound, healthy, vigorous and free of plant disease, borers, insect eggs and larvae, defects, decay, disfiguring roots, sunscald injuries, and abrasions of the bark; shall be well branched and full-foliaged when in leaf; shall have healthy normal root systems; shall have a normal habit of growth; and shall conform to the measurements shown in the plant list which are minimum sizes. Plants shall be measured before pruning with branches in a normal position. Plants larger in size than specified may be used with the approval of the Architect, but the use of larger plants will make no change in contract price. If the use of larger plants is approved, the ball of earth or spread of roots shall be increased proportionately.

C. Plants shall be freshly dug and nursery grown. Cold storage plants will be accepted.

D. Plants marked "cans, pots or other container" on the plant list shall have been grown in the containers for a minimum of six months and a maximum of two years. Roots shall fill the containers but show no evidence of being, or having been, root-bound. Plants shall not be picked up or moved by stems or branches, but shall be lifted and handled from sides of containers.

E. Balled Plants: Plants designated B&B in the plant list shall be adequately balled with firm, natural balls of soil of a diameter not less than for plant size required and of width and depth to encompass sufficient fibrous and feeding roots to insure full recovery and development of the plants. Ball shall be firmly wrapped with strong burlap. No balled plant will be accepted by the Architect when the ball of earth surrounding its roots has been cracked or broken, either preparatory to or during the process of planting; or when the burlap, staves, ropes, or platform required in connection with its use have been removed.

F. Any plant may be furnished container-grown instead of balled and burlapped if all other requirements are met.

G. Plants shall be handled so that roots and foliage are adequately protected at all time from drying out and from other injury. The balls of balled and burlapped plants which cannot be planted immediately on delivery shall be well protected with soil or other acceptable material, but not with manure or mushroom manure. Heeled-in plants shall be properly maintained until transplanted.

H. Plants shall not be pruned prior to delivery except upon special approval by the Architect.

I. Plants shall be marked for identification. Each bundle of plants and any one shipment shall have legible labels securely attached when delivered to the site.

2.3 PLANT MATERIALS

A. Annuals: Provide healthy disease-free plants of species and variety shown or listed. Provide only plans acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

B. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed.

C. Ground Cover: Provide ground cover of species shown or listed, established and well-rooted in pots or similar containers that comply with ANSI Z60.1 and following requirements.

2.4 MULCH

A. Peat Moss - As specified under 2.2-O, Organic Material.

B. Shredded Wood Chips - Hardwood or soft wood chips as produced by any standard machine. Chips shall be aged a minimum of 1 year and shall not contain any green growth of material. Chips shall not exceed 1" in greatest dimension.

C. Pine Bark Mulch

1. Pine bark nuggets, consisting of screened pine bark, free of cambium (inner bark), fines, wood and foreign matter. Required size range is 3/4" to 2" dimension.
2. Pine bark mulch, consisting of screened pine bark fines, free of cambium, wood and foreign matter. Required size range is fines up to 3/8" dimension.

D. Anti-Erosion Mulch: Provide clean, seed-free salt hay or threshed straw of wheat, rye, oats, or barley.

E. Anti-Desiccant: Emulsion type, film-forming agent designed to permit transpiration, but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accordance with manufacturer's instructions.

F. Plastic Sheet: Black, weather-resistant polyethylene sheeting, 0.008 inch (8-mils) thick.

G. Filtration/Separation Fabric: Water permeable filtration fabric of fiberglass or polypropylene fabric.

H. Wrapping: Tree-wrap tape not less than 4 inches wide, designed to prevent borer damage and winter freezing.

PART 3 - EXECUTION

3.1 PLANTING PROCEDURE

A. Time of Planting

1. Planting operations shall not occur at a time when:

a. Soil or backfill is frozen.
b. Soil is saturated.

3.2 PLANTING SHRUBS

A. Set balled and burlapped (B&B) stock of layer of compacted planting soil mixture, plumb and in center of pit or trench with top of ball at same elevation as adjacent finished landscape grades. Remove burlap from sides of balls; retain on bottoms. When set, place additional backfill around base and sides of ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing final layer of backfill.

B. Set bare root stock on cushion of planting soil mixture. Spread roots and carefully work backfill around roots by hand and puddle with water until backfill layers are completely saturated. Plumb before backfilling maintain plumb while working backfill around roots and placing layers of soil mixture above roots. Set collar 1 inch below adjacent finish landscape grades. Spread out roots without tangling or turning up to surface. Cut injured

roots clean; do not break.

C. Open potted plant containers and remove in a manner to leave earth around roots unbroken. Place plants in the plant pit, or trench, and carefully tamp prepared planting soil mix to fill voids under and around the base, and then backfill with prepared planting soil mix in 6" layers and compact to finish grade.

D. Prior to placing mulch, plants shall be treated at time of planting and initial watering with plant hormone and liquid fertilizer in full accordance with the directions furnished by the manufacturer shall be applied.

E. Soil acidifier shall be applied for all noted species, prior to placing mulch. Iron sulfate to be applied per manufacturer's directions.

F. Dish top of backfill to allow for mulching.

3.3 MULCHING

A. Cultivate all of each plant bed, and pits and trenches to the lines shown. Cultivate area around isolated plants at least 6" beyond diameter of pit.

B. Within 2 days after planting and cultivating have been completed, spread a layer of mulch on finished grade over the entire surface of each trench and plant bed, and at isolated plants, 6" beyond diameter of pit.

C. Ground cover beds shall be mulched with a 1" minimum layer of peat moss, lightly incorporated into the top 2" of soil, at time of planting.

D. Shrub pits and beds shall be mulched with 2" minimum layer of mulch as specified, spread neatly and left with a uniform flat surface.

E. Tree pits shall be mulched with a 3" minimum layer of mulch as specified, spread neatly and left with a uniform flat surface.

F. After leveling mulch, soak to full depth.

3.4 USE OF ANTI-DESICCANT

A. Each plant shall be treated at time of digging and again after installation with a spray application of anti-desiccant, in full accordance with the directions.

B. Spray each plant using an approved power sprayer to apply an adequate film over trunks, branches, twigs, and/or foliage. The time of the spraying shall be subject to approval. Care shall be taken to keep spray from blowing on structures or the public.

3.5 PRUNING

A. Prune, thin out and shape trees and shrubs in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed by Architect, do not cut tree leaders, and remove only injured or dead branches from flowering trees, if any. Prune shrubs to retain natural character.

B. Remove and replace excessively pruned or misformed stock resulting from improper pruning.

3.6 STAKING, GUYING AND WRAPPING

A. Shade, ornamental and evergreen trees to be supported and protected immediately after planting, as detailed and specified. The trunks of all deciduous trees greater than 6' in height shall be wrapped from the ground line up to the lowest main branch. Overlap of wrapping shall be 1-1/2". Securely tie wrapping with twine in at least 5 placed including top, middle and bottom.

3.7 CLEANUP AND PROTECTION

A. During landscape work, keep pavements clean and work area in an orderly condition.

B. Protect existing and new landscape work and materials from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape work as directed.

3.8 INSPECTION AND ACCEPTANCE

A. When landscape work is completed, including maintenance, Owner will, upon request, make an inspection to determine acceptability.

B. When inspected landscape work does not comply with requirements, replace rejected work and continue specified maintenance until reinspected by Architect and found to be acceptable. Remove rejected plants and materials promptly from project site.

3.9 FINAL INSPECTION

A. At the conclusion of the guarantee period, the Owner will make an inspection of the work to determine condition of the plants. Plants then not in a healthy, growing condition shall be removed from the site where found to be unsatisfactory and replaced with new plants of the same kind, sizes, and quality originally specified. Such replacements shall be made in the same manner as specified for the original planting and at no extra cost. After final inspection, there shall be no further guarantee of plant material.

END OF SECTION 02950

SECTION 03310 - CONCRETE, REINFORCEMENT AND FORMWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. Extent of cast-in-place concrete work is shown on the drawings. Provide all material and labor for required reinforcing, formwork and concrete work.

1. Coordinate, cooperate and assist with installation of items furnished and installed by other trades.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 1 Section "Special Inspections and Testing" for testing requirements.
2. Division 2 sections for concrete work related to sitework.

1.3 SUBMITTALS:

A. Manufacturer's Data - For standard factory manufactured materials, including specifications for application and installation of proprietary items and materials such as bonding agents, form release agent, admixtures and curing and sealing compounds.

B. Concrete design mixes and backup data - Refer to Section 2.4 - Concrete Mix Design - for requirements. Submit required information at least 5 weeks prior to initial concrete placement. Include test reports on the following:

1. Gradation analysis for coarse and fine aggregate.
2. Mill test reports on cement.
3. Compression tests on trial cylinders.
4. Slump and air content of trial batches.
5. Admixture certification, including chloride ion content.

C. Shop Drawings

1. Detail and placement Drawings to define the location, size, spacing, length, and shape of reinforcing. Indicate grades of reinforcing steel. Detail wall reinforcing on wall elevations. Include all other project requirements affecting reinforcing details and placing.
2. Shop drawings showing location of all construction joints, sleeves, depressions and curbs.

D. Samples to Testing Agency: Concrete constituents including admixtures.

E. Mill Test Reports: Certified copies of mill test reports for reinforcing steel, including statements of compliance with specified ASTM Standards.

F. Materials and methods for curing concrete.

G. Methods proposed for hot weather and cold weather curing and protection of concrete - submit prior to commencement of any concrete work.

H. Method of developing bond at joints.

I. Guarantee: Submit copies of the manufacturer's written guarantee that the Form Release Agent will not stain the concrete surfaces and will not adversely affect the bond of subsequent surface coatings.

1.4 QUALITY ASSURANCE

A. References: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

1. ACI
2. CRSI
3. PCA
4. ASTM

B. Tolerances

1. Formed Surfaces: Set and maintain concrete formwork to insure completed work is within the tolerance limits listed in ACI 347.
2. Flatwork: Finish concrete flatwork to the following surface profile tolerances when measured in accordance with ASTM E 1155:

a. All slabs on grade not otherwise specified:

(1) Overall Ff 25/Fl 20
(2) Local Ff 17/Fl 13

Whereby Ff = Face floor flatness number and F1 = Face floor levelness number.

C. Responsibility of the Contractor

1. The design, strength, safety and adequacy of all methods of construction, and the strength, slump, consistency, finish and general quality of concrete are the responsibility of the Contractor. No action by the Architect/Engineer will eliminate, lessen or restrict this responsibility in any manner.

1.5 QUALITY CONTROL

A. Testing Agency: The Contractor will engage a Testing Agency at his own expense, acceptable to the Owner, to perform detailed concrete quality control, testing and inspection. Provide the Testing Agency with the following:

1. Materials, samples, and access to materials as required for testing.
2. Minimum one day's advance notice when concrete is to be placed.
3. Incidental labor required to facilitate testing.
4. Copies of the delivery ticket of each load of concrete as it arrives at the jobsite.
5. Copy of the most current reinforcing steel shop drawings which have been reviewed by the Architect/Engineer, and access to the Contract Documents.
6. Reimbursement of costs for testing and inspection resulting as a consequence of the following;

   a. Work not in compliance with the Contract Documents.
   b. Testing requested by the Contractor or Subcontractor such as additional cylinders for early breaks, form removal, etc.
   c. Testing to verify the adequacy of work done without prior notice, without proper supervision, or contrary to standard construction practice.
   d. Changes in source, quality or characteristics of materials.
   e. Wasted time of inspectors because of cancellations or delays of concrete placement or other work.

B. Do not place concrete until the Testing Agency has reviewed and approved the work, and all reported deficiencies have been corrected. Concrete placed prior to approval is subject to removal.

C. Testing Agency Responsibilities:

1. Conduct the tests and inspections required herein, interpret and evaluate the results for compliance with the Contract Documents, and furnish reports of the results to the Owner, Architect/Engineer, Contractor, and Local Building Authority.
2. At the start of the job and whenever new bulk materials are delivered to the batching plant for use on the job, check the concrete constituents, including admixtures, for compliance with the Contract Documents.
3. At the start of the job perform an inspection of the Batch Plant and its operation. Observe the batching equipment, the condition of materials used, and check for conformance with the design mix proportions.
4. Perform concrete compression strength testing in accordance with ASTM C31 and C39. Sample concrete for test specimens at the point of deposit in accordance with ASTM C172. General concrete testing will consist of one (1) set of four (4) cylinders made from a single sampling for each 50 cubic yards or fraction thereof of each class of concrete placed each day. All test specimens are to be laboratory-cured. Test as follows:

a. One (1) 7 - day break.
b. Two (2) 28 - day breaks.
c. One (1) 56 - day break. Hold in reserve for testing if 28 - day breaks do not comply.
d. Immediately notify the Contractor and Architect/Engineer if 7 day strengths are less than 70% of design strength.

5. Determine the air content of concrete per ASTM C173 or ASTM C231 (normal weight concrete). For concrete required to be air-entrained, test the first truck and every 25 cu. yards thereafter each day.
6. Perform slump tests in accordance with ASTM C143. Test the first truck each day, and every time test cylinders are made. Provide a slump cone, plate and rod for use on the project at all times.
7. Perform unit weight test for first truck and each time cylinders are made.
8. Determine the temperature of each truckload of concrete during hot weather and cold weather concreting operations.
9. Observe the placement of all concrete. Inspect the formwork and the reinforcing steel placement, including grade of steel, prior to concrete placement.
10. Immediately notify the Contractor of any items which do not comply with the requirements of the Contract Documents. If satisfactory corrections are not made, contact the Architect/Engineer for direction before the concrete is placed.
11. Review the delivery tickets of the ready-mix concrete truck arriving on-site. Notify the Contractor if the concrete cannot be placed within the specified time limits or if the type of concrete delivered is incorrect. Reject any loads which do not comply with the Specification requirements. Rejected loads are to be removed from the site at the Contractor's expense. Any rejected concrete that is placed will be subject to removal. Refer to Part 3 - Corrective Work.
12. Measure concrete flatwork for levelness and flatness as follows:

    a. Perform Floor Tolerance Measurements Ff and Fl in accordance with ASTM E-1155.
    b. Perform all floor tolerance measurements within 48 hours after slab installation and prior to removal of shoring and formwork.
    c. Provide the Contractor and the Architect with the results of all profile tests within 72 hours after each slab installation.

D. Enforcement

1. When actual non-compliance and/or ominous trends are observed by the testing laboratory, promptly notify the Contractor and the concrete supplier who shall take immediate appropriate action to correct the deficiency.
2. Refer to Part 3 - Corrective Work - for concrete in place that does not comply with the strength requirements of the Contract Documents.

1.6 DELIVERY, STORAGE AND HANDLING

A. Sequence the shipment of material to the site to minimize field handling and storage.

B. Store the reinforcing steel on premises in a neat and orderly manner under cover and off ground. Protect the reinforcement from damage, dirt and corrosion. Provide proper drainage.

C. Comply with ACI 301, Section 5 and with ACI 304.

PART 2 - PRODUCTS

2.1 GENERAL

A. Use materials from the same source from the start to the finish of the project, unless a change is accepted in writing by the Architect/Engineer.

2.2 REINFORCING

A. Bar reinforcement - Newly rolled billet steel conforming to the following:

1. All reinforcing bars unless noted: ASTM A615 with Supplementary Requirements (S1) - Grade 60.

B. Welded Wire Fabric: ASTM A185. Deliver in sheets, not in rolls.

C. Reinforcement Accessories:

1. Provide all spacers, chairs, ties, slab bolsters, clips, chair bars, and other devices for properly assembling, placing, spacing, supporting, and fastening the reinforcement.
2. Use annealed tie wire of not less than #18 gauge.
3. Use individual and continuous slab bolsters and chairs of a type to suit the various conditions encountered.
4. Use accessories which conform to CRSI Bar Support Specifications, Class 1 or Class 2, in contact with surfaces exposed to view in the finished work.
5. Support reinforcement for slabs on grade on plastic or steel supports designed for the purpose or precast concrete bricks of a type approved by the Architect/Engineer. Wood blocks, stones, brick chips, etc., are not acceptable.

2.3 FORMWORK

A. Plywood

1. Use plywood complying with U.S. Product Standard PS-1, Exterior Type, edge sealed and mill oiled of the grade listed below. Minimum thickness of 3/4 inch or as required for spans and pressures. Use full size sheets where possible.

a. APA High Density Overlaid PLYFORM Class 1 for concrete exposed to

view.

b. APA B-B Plyform Class 1 for concrete not exposed to view.

c. APA Structural 1 PLYFORM where high fluid pressures are expected, with H.D.O. surfaces where exposed to view.

B. Metal Forms

1. Use proprietary metal or lined panelized wall and column forms capable of producing finished surfaces equal to those produced by the above specified plywood forms.

C. Pan Forms

1. Use smooth, undamaged steel or fiberglass pan forms conforming to the dimensions and shapes shown on the Drawings.

D. Keyed Edgeforms

1. Provide screed key joint with removable plastic cap strip equivalent to that as manufactured by Superior Concrete Accessories, Inc.

E. Form Release Agent: Provide a non-staining, non-emulsifiable type form release agent guaranteed not to adversely affect the bond of subsequently applied surface coatings. Form release agents containing fuel oil as a carrier are not permitted. The following are acceptable:

1. Euco Super Slip by Euclid Chemical Co.
2. Rich-Cote by Richmond Screw Anchor Co., Inc.
3. Debond Form Coating by L and M Construction Chemicals.
4. Noxcrete by Nox Chem Inc.

F. Form Ties: Provide ties of an approved design with a minimum working strength of 3,000 lbs. each, and adjustable to permit complete tightening of forms. After removal of the protruding part of the tie, no metal may be nearer than 1-1/2" to face of concrete.

1. That part of the tie which is to be removed shall be at least 1/2" diameter or, if smaller, provided with a wood, plastic or metal cone placed tightly against the inside of the forms.
2. Provide ties for walls below grade which incorporate a water seal washer.

G. Form Inserts and Embedments

1. Blockouts, Keyways: Wood or styrofoam.
2. Chamfer Strips: Wood, polyvinylchloride, or neoprene.
3. Joint Fillers: ASTM D1752, non-bituminous, nonextruding and resilient.
4. Waterstops: New stock polyvinyl chloride.
5. Nailing Strips: Pressure treated wood.

6. Anchoring Inserts: Provide proprietary type inserts where indicated.
7. Fabricated Embedments: Install only as shown in the Architectural and Structural drawings.

2.4 CONCRETE MIX MATERIALS:

A. Cement: American made Portland Cement, ASTM C150 Type I or II. Use only one brand of cement from one mill throughout the work.

B. Fine aggregate (normal weight): Washed, inert, natural sand conforming to ASTM C-33. Fineness modules of 2.40 to 3.00. For pumped concrete, 15 to 30 percent passing Number 50 sieve, and 5 to 10 percent passing a Number 100 sieve.

C. Coarse aggregate (normal weight): Washed, well graded crushed stone or gravel conforming to ASTM C-33.

D. Water: Potable, clean and free from deleterious substances.

E. Air Entraining Agent: Comply with ASTM C260, fully compatible with all other concrete mix materials. Subject to project requirements, provide products from one of the following:

1. W. R. Grace Co.
2. Euclid Chemical Co.
3. Sika Corp.
4. Master Builders Co.

F. Water Reducing and Plasticizing Admixtures: Comply with ASTM C494, Type A. Use in all structural concrete. Acceptable products are:

1. Eucon WR-75 by Euclid Chemical Co.
2. WRDA by W. R. Grace Co.
3. Pozzolith 322N by Master Builders Co.

G. Accelerating Agent: Non-corrosive, containing no chloride; conform to ASTM C494, Type C or E. Acceptable products are:

1. Accelguard 80 by Euclid Chemical Co.
2. Daraset by W. R. Grace Co.
3. Pozzutec 20 by Master Builders Co.
4. Plastocrete 161FL by Sika Corp.

H. Retarding Admixtures: For use in hot weather concreting. Comply with ASTM C-494, Type D water-reducing and retarding. Acceptable products are:

1. Plastiment by Sika Chemical Corp.
2. Pozzolith 200N or 220N by Master Builders.
3. Eucon Retarder-75 by Euclid Chemical Co.

2.5 MISCELLANEOUS RELATED MATERIALS:

A. Non-shrink, Non-Metallic Standard Cement Grout: Factory premixed grout with no drying, shrinkage or settlement at any age. Compressive strength per ASTM C1107 of not less than 5,000 psi at 7 days and 8,000 psi at 28 days when placed in flowable consistency. Acceptable products are:

1. Masterflow 555 by Master Builders Co.
2. Hi-Flow Grout by Euclid Chemical Co.
3. Duragrout by L & M Construction Chemicals.

B. Steel Fiber Reinforcement: ASTM A820, Type I cold drawn, high tensile steel wire for use as primary reinforcing in slab-on grade. Refer to Contract Documents for additional requirements. Acceptable products are:

1. Xorex by Novocon International, Inc.
2. Dramix Steel Wire Fibers by Bekaert Corporation.
3. Fibercon by Mitchell Fibercon.

C. Fibrous Reinforcement: ASTM C1116, Type III collated, fibrillated, polypropylene fibers for use as secondary reinforcement in concrete flatwork. Dispense in accordance with manufacturer's written instructions at minimum rate of 1.5 pounds per cubic yard. Acceptable products are:

1. Fibermesh by Fibermesh, Inc.
2. Forta CR by Forta Corp.

D. Epoxy Resin Bonding Agent: ASTM C881 two component 100 percent solids mineral filled epoxy-polysulfide polymer. Acceptable products are:

1. Sikadur 32 Hi-Mod by Sika Corporation.
2. Euco Epoxy No. 452MV or No. 620 by Euclid Chemical Company.
3. Sonobond by Sonneborn Contech.

E. Non-shrink Patching Mixture: Specially formulated high bond package mixture. Acceptable products are:

1. Euco Speed Patch by Euclid Chemical Co.
2. Durapatch by L & M Construction Chemicals.
3. Sonopatch by Sonneborn Contech.
4. Sika Set Roadway Patching by Sika Corp.

F. Vapor Retarder: Product must meet requirements of ASTM E 1745, Class C. Minimum permeance of 0.04 perms per ASTM E-96 minimum thickness of 10.0 mils per ACI 302. Install per ASTM E-1643. Lap and tape joints a minimum of 6", and seal laps, along walls, and at all penetrations with a compatible trowel mastic or pressure sensitive tape. Acceptable products are:

1. Stego Wrap by Stego Industries
2. Griffolyn T-85 by Reef Industries
3. Dura-Scrim D16WB by Raven Industries

2.6 CONCRETE MIX DESIGN

A. Engage a Technical Agency familiar with local construction conditions and materials to design concrete mixes.

B. Review with the Technical Agency the project concrete mix requirements relative to strength, slump, air content and seasonal adjustments.

C. Provide separate design mixes for each anticipated and/or actual changes in type of mix materials. Identify the proposed use for each mix.

D. Prepare the mix designs with sufficient lead time to allow testing and adjustment of the mix. Establish the concrete mix design proportions to provide the required average strength using the procedures defined in Chapter 5 of ACI 318.

E. Submit the complete design mix along with the appropriate test data and technical data to the Architect/Engineer for review prior to job use.

F. Concrete mix design submittals that are incomplete or do not satisfy the requirements of the Specifications will be rejected. Additional testing and/or revisions to the mix design may be required to achieve compliance. Do not place any concrete in the Work until design mix submittal(s) satisfactory to the Architect/Engineer have been reviewed and accepted. Keep a copy of the reviewed mix designs on file in the field office.

G. In addition to the concrete mix design requirements listed above, limit the water/cement ratio to the following maximums:

1. 0.40 for concrete exposed to deicing salts.
2. 0.45 for concrete required to be watertight and/or subject to cycles of freezing and thawing. (including foundation walls)
3. 0.50 for all concrete not otherwise specified.

H. Provide air entrainment for all concrete in pavements, all exterior concrete or concrete otherwise exposed to cycles of freezing and thawing. Comply with ACI 318, Table 4.2.1 “Severe Exposure” for amount of air entrainment.

I. Provide a water reducing (plasticizing) admixture for all structural concrete.

J. Proportion design mixes to result in concrete with the following slumps at the point of placement:

1.	Pavement and slabs on grade	4" +/- 1"
2.	Footings	3" +/- 1"
3.	Reinforced walls and columns	4" +/- 1"
4.	All other concrete	3" +/- 1"

K. Use the following maximum coarse aggregate sizes per ASTM C33:

1. Size 467 for slabs on grade and foundations.
2. Size 57 for slabs, walls and beams.
3. Size 7 for tight pours and thin sections.
4. Size 67 for all other concrete.

L. Adjust mix designs that do not provide to be satisfactory in use, subject to the Architect/Engineer's review. Concrete that does not consistently exhibit the specified control characteristics will be considered unsatisfactory. Any additional costs incurred due to changes required in the mix are to be borne by the Contractor.

M. Provide additional mix designs and appropriate test data for any revisions to the approved concrete mix designs requested by the Contractor during the course of work. Do not use the revised mix until reviewed and accepted by the Architect/Engineer.

2.7 MIXING AND DELIVERY OF CONCRETE:

A. Supply all concrete from a ready-mix plant acceptable to the Architect/Engineer. Batch all constituents, including admixtures, at the central batch plant.

B. Comply with ACI 304 recommendations. Accurately weigh all materials. Mix, dispense and use admixtures in accordance with the specific manufacturer's written instructions.

C. Conform with Truck Mixer and Agitator Standard of the Truck Mixer Manufacturer's Bureau of the National Ready-Mixed Concrete Association, as well as ASTM C94. Do not load trucks in excess of NRMCA Ratings for normal weight aggregate concrete.

D. Water may be added initially to concrete which arrives at the site with a slump below the specified slump if, after the addition of water, neither the maximum permissible water/cement ratio nor the maximum slump is exceeded. Provide thorough additional mixing. The Owner's Testing Agency will observe the adding of water and mixing. Retempering after initial slump adjustment is not permitted.

E. Discharge of Materials: Discharge concrete without segregation of the ingredients. Incorporate all concrete in the work of its final shape and location within 90 minutes after the introduction of water to the mix or within a shorter time period as the testing agency may direct during hot weather. Immediately remove all concrete materials from the construction site not incorporated into the Work within the specified time limits.

F. Cold Weather Requirements: Comply with ACI 306 whenever ambient air temperatures

are below 40 degrees F. Heat the mixing water and, if necessary, the aggregates to produce concrete at the temperature specified in ACI 306, Table 1.4.1 when placed.

G. Hot Weather Requirements: Comply with ACI 305 whenever conditions of high air temperature, low relative humidity and/or wind exist. Provide crushed ice if necessary to provide concrete of the proper temperature. Ice must be completely dissolved before placing concrete. At the Contractor's option, liquid nitrogen may be used to cool the concrete.

2.8 FABRICATION OF REINFORCEMENT:

A. Accurately form the reinforcement to dimensions on the approved shop drawings, details and schedules.

B. Do not commence fabrication until the shop drawings, details, and schedules have been reviewed by the Architect/Engineer.

C. Cold bend all reinforcement. Do not heat reinforcing for any purpose.

D. Do not form bars in a manner injurious to the bars. Bars with kinks or bends not shown on the Drawings and bars reduced in section will be rejected.

2.9 DESIGN OF FORMS AND SHORING

A. Design formwork, shoring and bracing to sustain all construction and wind loads, and to maintain concrete lines and levels within specified tolerances. Design the forms to permit easy removal. Prying against the face of the concrete will not be allowed. Limit the deflection of each formwork component to 1/360 of the component span.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMS AND SHORING

A. Build forms mortar-tight with edges sealed to prevent loss of concrete matrix. Edges of form panels, in contact with previously cast concrete, are to be flush within 1/16 inch. Continually adjust forms for line and elevation during concrete placement as required.

B. Provide removable panels in the bottom of wall and column forms to facilitate cleaning, inspection and application of bonding paste.

C. Do not place concrete through holes in the sides of forms.

D. Chamfer all corners unless noted otherwise.

E. Before placing reinforcement on or against surfaces of forms coming in contact with fresh

concrete, clean the surfaces and treat them with the approved form release agent.

F. Before form materials are re-used, thoroughly clean surfaces, repair damaged areas and withdraw all projecting nails from formwork surfaces that will be in contact with freshly cast concrete.

3.2 INSTALLATION OF EMBEDDED ITEMS AND COORDINATION WITH OTHER TRADES:

A. Install all embedded items to conform to the requirements of ACI 318, Chapter 6, Paragraph 6.3, "Conduits and Pipes Embedded in Concrete", and as specified below. Do not install any accessories until their type and location have been verified by the affected trades.

B. Coordinate the installation of all inserts required by other trades prior to the placing of reinforcing steel.

C. Install anchor bolts, etc., furnished by other Sections. Use line and transit to locate anchor bolts and secure with templates to prevent displacement during concreting operations.

D. Provide steel sleeves for pipes passing through concrete.

3.3 INSTALLATION OF REINFORCEMENT

A. Install reinforcing only from Shop Drawings which have been reviewed by the Architect/Engineer.

B. Accurately place and rigidly secure reinforcing in position in accordance with the requirements of CRSI “Placing Reinforcing Bars” and Chapter 3 of the CRSI “Manual and Standard Practice” for Placing Bar Supports and requirements specified herein and on the Drawings.

C. Tie reinforcing with specified tie wire, and bend all wire back beyond general plane of reinforcing.

D. Bending, tack welding, cutting or substituting reinforcement in the field, other than that shown on the Contract Drawings, is prohibited.

E. Remove any excessive rust, scale, or other coatings from the reinforcement which might destroy or reduce bond prior to placing concrete.

F. Avoid exposure of reinforcement to the weather for any considerable length of time before placing of concrete.

G. Before the concrete is cast, check all reinforcement after it is placed to insure that reinforcement conforms to Contract Drawings, approved shop detail drawings and

Specification requirements.

H. Remove and replace damaged bars.

I. Splice the reinforcing only as shown on the Drawings or as approved by the Architect/Engineer.

3.4 PLACING CONCRETE:

A. Comply with ACI 301, Section 5 and as modified below.

B. Transport concrete mixes to place of final deposit as rapidly as practical by methods which prevent segregation of the ingredients and displacement of reinforcement. Avoid rehandling. Do not deposit any partially hardened concrete. Use a downpipe, elephant trunk, spout or other appropriate method to prevent concrete from falling freely through a height of more than 3 feet. Do not allow concrete to flow horizontally within forms over a distance exceeding 5 feet. Do not move concrete horizontally with vibrators. Provide runways for wheeled equipment to move over reinforcement. Do not support runways on reinforcement.

C. Schedule the work so that a section begun on any one day is completed in daylight on the same day.

D. Remove water and all foreign matter from place of deposit. Do not place any concrete into any form or excavation containing free water, trash, frost, ice or frozen ground. Provide adequate protection against frost action during freezing weather. Do not place concrete flatwork in the rain. Protect exposed concrete surfaces from rain until final set occurs.

E. Do not use calcium chloride in any concrete.

F. Deposit concrete continuously in layers of a thickness that will prevent new concrete from being deposited on partially hardened concrete. Limit height of vertical lifts to 24". Do not allow formation of seams and planes of weakness within the section. Vibrate through successive lifts to avoid pour lines, stone pockets, honeycombing and segregation.

G. Thoroughly compact concrete by means of internal mechanical vibrators to produce required quality of finish.

H. Thoroughly clean chutes, hoppers, spouts, adjacent work, etc., before and after each run. Discharge the water and debris outside the form.

I. Finish all structural slabs and slabs on grade to the elevations shown on the Contract Documents. Provide additional concrete as necessary to compensate for all settlements and deflection due to the weight of the wet concrete.

3.5 FINISHING OF FORMED CONCRETE SURFACES:

A. Comply with ACI 301, Section 5 and as modified below.

1. Remove fins and grind if necessary. Provide rough form finish for surfaces not exposed to public view and smooth form finish for all concrete surfaces exposed to public view.

3.6 FINISHING FLATWORK

A. Preliminary Slab Finishing: For all slabs regardless of final finish:

1. Rough Finishing: Accurately strike off the top surface of the flatwork to provide a true and level surface within the required tolerances. After concrete has been placed, consolidated, and struck off, screed and bull float or darby the surface. Remove all water and foreign material which may work to the surface as soon as the condition of the slab permits, and before it has hardened appreciably. Recheck the surface for trueness and levelness; restraighten, fill, or cut down with a 10' highway straightedge.
2. Power Troweling: Wait until the water sheen has disappeared or the mix has stiffened sufficiently to permit the proper operation of a power driven trowel. Power trowel the surface to produce a smooth surface which is relatively free of defects. Hand float locations inaccessible to the power driven machine. Recheck trueness of surface with a 10' highway straightedge applied at no fewer than two different angles. Cut down high spots and fill in low spots to produce a finished surface within the specified tolerances.

B. Floated Finish: After rough finishing and power troweling as specified above, float the slab immediately using a wood float to produce uniform smooth granular texture.

1. Slabs to receive built-up roofing or membrane waterproofing.
2. Slabs to receive quarry tile and sand bed terrazzo.
3. Top surfaces of walls, curbs, or other surfaces not requiring a steel troweled surface.

C. Steel Troweled Finish: Perform additional hand troweling as soon as the surface has hardened sufficiently to produce a ringing sound as the trowel is moved over the surface. Produce a uniform, smooth surface free of trowel marks or other defects. Provide steel troweled finish on the following surfaces:

1. Slabs to receive carpeting.
2. Slabs to receive seamless floor finish.
3. Slabs to receive resilient tile.
4. Stairs.
5. Slabs to be left exposed and not specified to receive another finish.
6. Top surface of equipment pads.

D. Sealed Finish: Apply initial coat of concrete curing and sealing compound as specified beyond under "Curing - Moisture Retention". Just prior to the completion of the project, apply a second coat to the following surfaces:

1. All concrete floors within the building not receiving another finished material as called for in the Contract Documents.
2. All exterior curbs, paving, and other exposed surfaces including those specified in Division 2.

E. Broomed Finish: After rough finishing as specified above, and just prior to final set, broom the entire surface uniformly ;with a stiff broom to remove all scum, laitance, etc., without muddying the surface. Provide broomed finish on the following surfaces:

1. Slabs to receive floor fill concrete or monolithic topping.
2. Traffic paving and ramp traffic surfaces not to receive "traffic topping". Apply broom in the direction perpendicular to the main traffic route.
3. Exterior walkways and paving - Refer to Division 2.

F. Sawcutting: Begin sawcutting as soon as the saw will not dislodge the aggregate or ravel the edge of the sawcut, but in no case longer than 12 hours after the slab is placed. Sawcut a minimum of one quarter of the slab depth leaving a clean, sharp edge in the pattern shown on the Contract Documents. Provide sufficient personnel and equipment to complete sawcutting operations within 18 hours after the slab is placed.

G. Exposed surfaces with fibrous reinforcement. After curing of the concrete, burn off any protruding fibers in a manner which will not harm the parent concrete.

3.7 CURING, PROTECTION AND FORM REMOVAL:

A. General:

1. Comply with ACI 301, Section 5 and as modified below.
2. Protect freshly placed concrete from premature drying, mechanical damage and excessively cold or hot temperatures and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.
3. Start initial curing as soon as free moisture has disappeared from the concrete surface after placing and finishing.

B. Curing-Moisture Retention: Maintain the concrete in a continually moist condition for a minimum of 7 days. Avoid rapid drying at end of curing period.

1. Formed surfaces - Keep the forms continuously wet by periodic spraying with water. After the forms are removed, continue moist curing by one of the methods described for unformed surfaces.
2. Unformed surfaces - Retain moisture in the concrete by immediate application of one of the following methods:

a. Ponding or continuous fog spray (mist) of water - periodic sprinkling is not acceptable.
b. Apply an absorptive cover or a layer of sand and keep continuously wet.
c. Apply continuous waterproof sheets - lap and seal seams and repair any holes or tears.
d. Apply a specified liquid membrane forming curing and sealing compound at the manufacturer's specified rate and method of application to comply with specified water retention. Apply as soon as possible after final finishing operations are complete. Apply in two (2) directions, the second application perpendicular to the first.

C. Curing-Temperature: Maintain the temperature of the concrete at 50 degrees F. or above during the curing period. Keep the concrete temperature as uniform as possible and protect from rapid atmospheric temperature changes.

1. Cold Weather Concreting:

a. Comply with ACI 306R whenever the average daily temperature is less than 40 degrees F.
b. Heat the formwork, reinforcing and underlying subgrades with live steam or hot air jets to raise the temperature of each well above freezing prior to placing concrete. Provide concrete of at least the temperature shown in Table 3.1 of ACI 306. Heat, insulate, cover, enclose and protect the concrete as necessary to continuously maintain the concrete temperature between 50 degrees F. and 60 degrees F. for the entire curing period. Do not allow temporary heaters to exhaust combustion gases into the enclosed space containing the slab surfaces.
c. Non-chloride accelerators may be used in cold weather after review and acceptance by the Architect/Engineer.

2. Hot Weather Concreting:

a. Comply with ACI 305R whenever the atmospheric temperature or the form surface temperature is at or above 90 degrees F., or climatic conditions of wind and/or low humidity will cause premature drying of the concrete.
b. Cool the formwork and underlaying subgrades to a maximum of 80 degrees F. and keep moist. Cool the temperature of the concrete to 75 degrees F. by substituting ice for mixing water or other methods.
c. Take precautions before placing concrete to prevent rapid moisture loss from the concrete surface. Erect sunshades and windbreaks, provide continuous fog spray of water and/or other protection as necessary to accomplish this.

d. Schedule placements of concrete flatwork to begin in the late afternoon if daytime temperatures and drying conditions are critical.

e. Suitable retarders may be added to the concrete mix if the retarder mix design has been reviewed and accepted by the Architect/Engineer prior to use on the project.

D. Protection from Mechanical Injury: During the curing period, protect concrete from damaging mechanical disturbances including excessive vibration, and from damage caused by rain or flowing water. Protect finished concrete surfaces from damage by subsequent construction operations.

E. Temperature Records: Maintain a set of record drawings on site on which the progress of work is shown. Indicate the day, time, and ambient temperature at time of placement for each concrete pour. Keep a permanent log showing the date and the outside and concrete temperatures during all concreting operations (including curing).

F. Form Removal: Remove forms in a manner which insures building safety. Do not remove supporting forms or shoring until members have acquired sufficient strength to safely support their weight and all subsequent construction loads without deflections exceeding 1/360.

3.8 REPAIR OF DEFECTIVE CONCRETE SURFACES:

A. Comply with ACI 301, Section 5 and as modified below.

B. Identify those areas requiring repair, and review locations with Architect/Engineer and Owner's Testing Agency on a case by case basis. Refer to Section "Corrective Work" where it is determined by the Architect/Engineer that the load carrying capacity of the concrete may be jeopardized. If it is determined that only surface repairs are necessary, submit a proposed repair procedure, outlining a description of materials, sequencing, preparation, etc., for review.

1. Cut out defective concrete down to sound concrete leaving neat, square cut edges.
2. Where reinforcement is exposed by removal of defective concrete, cut around reinforcement to provide a clear space not less than 3/8" wide on all sides of the bar.
3. Thoroughly saturate the concrete surface to receive the patch for several hours prior to application of patching materials. Remove excess water to obtain saturated, surface dry substrate. Apply primer or scrubcoat of bonding agent according to the manufacturer's instructions.
4. Prepare mortar using approved premixed patching mixture.
5. Do not mix more mortar than can be placed in 20 minutes. Apply in layers according to the manufacturer's instructions.
6. Finish the final layer to match the existing concrete surface in color and texture.

C. Provide repairs with the strength, elasticity and durability equal to the parent material being repaired. Remove and replace patches which become crazed, cracked, sound hollow upon

tapping, or, which in the opinion of the Architect/Engineer do not satisfy the requirements of the Contract Documents.

D. When flatness and levelness testing indicates concrete flatwork that does not comply with the specified tolerances, grind the surface to adjust flatwork to within tolerance requirements. Perform grinding as soon as possible after the concrete is strong enough to prevent dislodging of the coarse aggregate, preferably within 3 days.

E. All patching and repairs shall be performed at the Contractor's expense.

3.9 CORRECTIVE WORK:

A. Concrete in place will be considered defective if cylinder strength test results do not meet the requirements of ACI 318, Section 5.6. Additional causes for rejecting concrete include, but are not limited to, concrete placed with excessive slump, insufficient air content, beyond specified time limits, with unauthorized retempering, without proper supervision or inspection, improper curing or protection, or if there is visible evidence of scaling, cracking, voids or excessive deflection.

B. If, in the Architect/Engineer's opinion, the strength, stiffness or durability of the structure may be compromised, test specimens may be taken from the structure at locations designated by the Architect/Engineer. Obtain and test the specimens in accordance with ASTM C42. Test results which indicate non-compliance with the Specifications are cause for rejection. Alternatively, at the Architect/Engineer's discretion, load tests may be performed and evaluated in accordance with ACI 318, Chapter 20.

C. Remove and replace concrete that, in the Architect/Engineer's opinion, does not satisfy the performance requirements of this Specification if repairs cannot be accomplished to the Architect/Engineer's satisfaction.

D. Where it is determined that repairs may be attempted, submit a complete repair procedure to the Architect/Engineer for review. Include all necessary information on proposed products, preparation, and sequence of repair including manufacturer's specifications and installation instructions. Do not proceed with repairs until this procedure has been reviewed and accepted by the Architect/Engineer. The repair must account for the strength, stiffness and long term durability of the entire structural element under repair.

E. The costs of all tests and additional services required of the Architect/Engineer, as required, and for repair or removal and replacement are at the expense of the Contractor.

3.10 GROUTING OF ANCHOR BOLTS AND BASE PLATES:

A. Grout Mixture: Use an approved packaged grout mix with the minimum amount of water required to produce a flowable grout. Extend grout with 3/8" coarse aggregate for grout

placements over 2 inches thick.

B. Mixing: Per approved grout manufacturer's printed instructions. Do not mix more grout than can be placed within 20 minutes.

C. Preparation:

1. Remove all defective concrete, laitance, dirt, etc. from the concrete surface. Saturate the surface of the concrete thoroughly with clean water for at least 24 hours. Remove free water just prior to placing the grout.
2. Clean, align, and level the base plate into final position and maintain that position during grouting. Bring the concrete and plate to be grouted to a temperature between 65 degrees to 90 degrees F. just prior to grouting.

D. Grouting:

1. Place the grout quickly and continuously to provide complete bearing and avoid air entrapment.
2. After the grout has acquired its initial set, cut off all unconfined, exposed edges, leaving sloping "shoulders". Paint the entire exposed area within 24 hours with an approved curing compound.

END OF SECTION 03310

SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. Extent of structural steel work is indicated on the drawings, including schedules, notes and details to show the size and location of members, typical connections, and type of steel required.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section "Special Inspections and Testing" for testing requirements.
2. Division 3 Section "Cast-in-Place Concrete" for grouting of anchor rods, base plates and bearing plates.
3. Division 5 Sections relating to Miscellaneous Metal Fabrications.
4. Division 9 Sections for painting top coats of exposed steel. Primer and surface preparation specified herein.

1.3 SUBMITTALS:

A. Shop Drawings: Submit shop drawings to include all information necessary for fabrication and erection as follows:

1. Details of proposed connections for each member size, steel grade, connection type and design reaction indicated on the drawings. Use standard details where appropriate. Refer to Part 2 - Products "Design" for criteria.
2. Structural calculations prepared and sealed by a qualified engineer registered in the State of Ohio for each connection condition indicated above. Submit calculations for review before preparation of Detail Drawings.
3. Base plate and anchor bolt plans showing the location, size and identification marks of all base plates, screws, bolts, grades of steel and setting elevations.
4. Erection Plans (minimum 1/8" = 1'-0" scale) showing type, size, weight and identification marks of all structural steel members. Include temporary members required for erection, dimensions locating all members relative to column grid lines, elevations of all members, and clear cross references with all other related drawings. Also include the necessary information and instructions regarding field welds and field bolts including type, size and extent of field welds, types of electrodes, joint welding procedures, welding sequence and size and type of field

bolts.

5. Detail Drawings showing complete details for the fabrication of all structural steel members and components including, but not limited to: identification marks, dimensions, size, type, weight and grade of steel; requirements for installation of other materials or parts of construction, such as punched or drilled holes, cleats, openings, etc.; type, size and extent of shop and field welds; type of electrodes, joint welding procedures; welding sequences; size and type of shop and field bolts; cleaning requirements prior to painting; type and dry thickness of paint. Use welding symbols used by the American Welding Society.
6. Drawings and calculations of all shop and field modifications and/or remedial work.
7. Drawing index sheets, including up-dated sheets, at the same time that details are submitted.
8. Contract Document plan drawings may be reproduced by the Contractor with the following provisions:
    a. Plan drawings may be reproduced only to locate piece marks. The responsibility for producing complete and accurate shop drawings remains with the Contractor.
    b. The Contractor must remove all title blocks, notes, references, revision marks, and section marks referring to the Contract Document plan drawings.
    c. Only the plans, modified as described above, may be reproduced. Contract Document detail drawings may not be reproduced, in whole or in part, for any reason.

B. Product Data: Submit copies of manufacturer's specifications and installation instructions for each proprietary product, including laboratory test reports and such other data as may be required to show compliance with the specifications. Indicate by transmittal form that copies of such data have been distributed to Fabricator/Installer and the Owner's Testing Laboratory.

1. Certified copies of mill reports covering the chemical and physical properties of the steel.
2. High strength bolts, each type, including nuts and washers.
3. Unfinished bolts and nuts.
4. Welding electrodes, each type.
5. Shop coat primer paint.

C. Record Surveys: Submit three (3) copies of certified survey(s) by the Contractor's registered professional surveyor as specified in Part 3 - Execution.

D. Contractor's Shop Testing Reports: Submit in triplicate directly to the Architect/Engineer with copies to the Contractor, Owner's Testing Laboratory and others as indicated.

Document all of the certifications, tests and inspections specified.

E. Owner's Testing Laboratory Reports: Submit in triplicate directly to the Architect/Engineer, with copies to the Contractor and others as indicated. Document all of the certifications, tests and inspections specified.

F. Substitutions: Substitutions for the member sizes, type(s) of steel, connection details, or any other modifications proposed by the Contractor will be considered by the Architect/Engineer under the following conditions:

1. The revisions in no case result in additional cost to the Owner. In considering cost savings to the Owner, adequate compensation for the Engineer's review of these substitutions should be considered.
2. The request is made in writing and accepted prior to the submission of shop drawings.
3. It is suitably demonstrated that there is a substantial cost advantage or time advantage to the Owner.
4. Sufficient sketches, engineering calculations by a Structural Engineer registered in the State of Ohio, and other data are submitted to facilitate review by the Architect/Engineer.

1.4 QUALITY ASSURANCE:

A. Fabricator's and Erector's Qualifications

1. Provide written evidence that the Fabricator and Erector have satisfactorily completed work of similar scope and have the necessary skill, equipment, facilities and capacity to fabricate the structural steel and to perform the erection in accordance with the construction schedule and in compliance with all requirements of the Contract Documents. Submit evidence whether or not the fabrication facility is certified as an AISC Conventional Steel Building Structures (SBD) facility.

B. References - Except as modified by governing codes and as otherwise specified herein, perform work in accordance with the provisions and recommendations of the latest editions of the following codes and standards:

a. "Load and Resistance Factor Design Specification for Structural Steel Buildings," American Institute of Steel Construction, including Commentary.
b. "Code of Standard Practice for Steel Buildings and Bridges", American Institute of Steel Construction.
c. "Manual of Steel Construction - Load and Resistance Factor Design," American Institute of Steel Construction.
d. ASTM A6 "General Requirements for Delivery of Rolled Steel Plates,

Shapes, Sheet Piling and Bars for Structural Use".

e. "Recommended Procedure for Identification of High Strength Steels During Fabrication," American Institute of Steel Construction.

f. "Structural Welding Code-Steel" (AWS D1.1), American Welding Society.

g. Specification for Structural Joints Using ASTM A325 or A490 Bolts," Research Council on Structural Connections of the Engineering Foundation (RCSC).

h. "Steel Structures Painting Manual," Volumes 1 and 2, Steel Structures Painting Council (SSPC).

i. "Handbook on Bolt, Nut and Rivet Standards" Industrial Fastener Institute.

j. All pertinent Federal, State and Local codes which govern safety requirements for steel erection, including 29 CFR Part 1926 Subpart R – OSHA regulations for steel erection.

k. Keep copies of these codes and standards available in shop and field.

l. In case of conflict between specified codes and standards, the most stringent requirements govern. In case of conflict between specified codes and standards and project Specifications, project Specifications govern.

1.5 TESTING:

A. Contractor's Shop Testing, Inspection and Quality Control

1. For AISC certified facilities, submit a written program for the proposed fabrication quality control testing and inspection. After review and acceptance of these documents by the Architect/Engineer, perform all shop testing and inspection as specified herein.

2. Structural Steel Fabrication Shop Quality Control Program: As a minimum, perform at least the following shop tests and inspections and submit daily reports of the results of all tests. State in each report whether the tested specimens conform to all requirements of the Contract Documents, and specifically note any discrepancies. If the inspections indicate defects in the Work, increase the degree of testing to insure that the full extent of defects in the joint are found and that similar defects are not present in similar joints.

a. Provide written evidence that all welders to be employed in the Work hold current AWS certification for the welding procedures that each will perform. If re-certification of welders is required, the retesting is the Contractor's responsibility.

b. Provide visual and acoustic inspection of all headed anchor studs used on connection plates embedded in concrete. Bend test 20% of all studs, a minimum of 1 per plate, at random.

c. Visually inspect all fabrication operations, including dimensional and fit-up/alignment and control.

d. Visually inspect all plate edges and rolled shape edges for material defects.

e. High Strength Bolted Connections

(1) Check all bolted connections in accordance with the procedures outlined in the RCSC "Specification for Structural Joints Using ASTM A325 or A490 Bolts", latest edition.

f. Welding Visual Inspection

(1) Inspect all welding operations and welds, including edge preparation, fit-up, preheat, and adherence to welding procedures. Inspect welds prior to shop painting of steel.

(2) Measure the weld profiles for 15% of the length of each weld, at random.

g. Welding Magnetic Particle Testing: Test in accordance with ASTM E709 for a minimum of:

(1) 20% of all shear plate fillet welds at random, final pass only.

(2) 20% of all continuity plate and bracing gusset plate fillet welds, at random, final pass only.

(3) 100% of tension member fillet welds (i.e., hanger connection plates and other similar connections) for root and final passes.

h. Schedule all work to allow the testing requirements listed above to be completed.

B. Independent Testing Laboratory

a. The independent Testing Laboratory hired by Contractor, will conduct a program of testing and inspection for field erection.

2. Field Quality Control - Perform the following quality control tests and inspections. Interpret test results, submit daily reports and monthly summary reports.

a. Examine the Manufacturer's test certificates for all materials provided. Verify that the lot numbers of the tested material coincides with the lot numbers of the material used on-site.

b. Perform full time visual inspection of the field erection of 100% of the structural elements.

c. Visually inspect all anchor-bolt nut installation and tightening.

d. High Strength Bolted Connections:

(1) Observe the job site calibration of each size bolted fastener assembly and installation technique in the calibrated tension measuring device. Verify that the proper bolt pretension listed in Table 8.1 of the RCSC "Specification" is achieved and that installation equipment is of sufficient capacity.

(2) Routinely monitor field bolting procedures during bolt

installation. Verify that all bolts in all connections are brought to a "snug tight" condition with all plies of the connection in firm contact. Verify that bolts in connections identified as either slip-critical or direct tension connections are being additionally tightened by the proper technique(s) determined in the tension testing device described above.

(3) Check that all bolted connections are being installed in accordance with the procedures outlined in the RCSC "Specification."

e. Welded Connections

(1) Obtain qualifications of all welders and verify all welding procedures, including the Contractor's compliance with preheat, weather-protection, electrodes, and welding surface preparation requirements.

(2) Visually inspect all field welding operations and welds.

3. Schedule all work to allow the testing requirements listed above to be completed.

4. Testing and inspection do not relieve the Contractor of the responsibility for providing materials and fabrication procedures in compliance with the specified requirements.

1.6 DELIVERY, STORAGE AND HANDLING

A. Sequence the shipments of material to expedite erection and minimize field handling.

B. Store materials to protect them from damage, dirt, contamination and corrosion. Maintain proper lubrication on all high strength bolts. Provide proper drainage. Provide adequate support for stored material to prevent overstressing either new or existing construction.

C. Handle materials in a manner which protects surfaces and prevents distortion or other damage to either fabricated pieces or existing construction.

D. Repair or replace damaged materials or structures as directed by Architect/Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Structural Steel: Newly rolled steel conforming to the following minimum requirements:

Shape/ Type		ASTM Grade	Yield Strength (Fy in Ksi)
1.	Rolled WF & WT	A992	50
2.	Plates	A 36	36

		A572	42, 50
3.	Square/Rectangular HSS	A500 Grade B	46
4.	All Other Steel	A36	36

B. High Strength Bolts, Nuts and Washers: ASTM A325 or A490; cold forged with rolled threads. Do not mix A325 and A490 bolts of the same diameter. Different grade bolts must vary in diameter by a minimum of ¼ inch.

C. Galvanized High Strength Bolts: ASTM A325 Type 1 only. Bolts and nuts to be shipped as assembly from same supplier.

D. Anchor Rods for base plates: ASTM A36, ASTM A 449 as shown on Contract Documents.

E. Unfinished Threaded Fasteners - ASTM A307 Grade A.

F. Galvanizing: Hot dip galvanize steel where indicated as follows:

1. Rolled, forged and pressed shapes - ASTM A123.
2. Iron and steel hardware - ASTM A153.
3. Assembled steel products - ASTM A123.
4. Welds subsequent to galvanizing - coat with approved zinc rich primer.

G. Filler Metal for Welding: Conform to AWS Code D1.1 with addenda and the following requirements:

1. Shielded metal-arc welding, AWS A5.1 and A5.5, E70 series.
2. Submerged arc-welding, AWS A5.17 and A5.23.
3. Flux Core Arc Welding: AWS A5.20 and A5.29.
4. Do not use gas metal arc (MIG) welding for structural connections.

H. Torque Control Bolts:

1. LeJeune T.C. Bolts, LeJeune Bolt Company, Lakeville, Minnesota.
2. Bolts, T.C. Bolt Corporation, Greenfield, New Hampshire.
3. Tru-Tension Bolts, Nucor Corporation, St. Joe, Indiana.

I. Direct Tension Indicators, ASTM F959.

1. "Coronet Load Indicators" by Cooper and Turner, Youngstown, Ohio.
2. "Load Indicator Washers" by Beth-Fast, Minneapolis, Minnesota.

J. Expansion Anchors - Install in accordance with manufacturer's printed instructions. Use only with prior review and acceptance by the Architect/Engineer for the specific applications indicated. Minimum service load capacity in pounds per anchor:

Diameter	Tension	Shear

3/8”	900	1200
½”	1400	2200
5/8”	2500	3300
¾”	3800	4200
7/8"	4500	6000

K. Resin Capsule Anchors - Install in accordance with manufacturer's printed instructions. Use only with prior review and acceptance by Architect/Engineer for the specific applications indicated. Subject to compliance with requirements, provide one of the following:

1. Adhesive Anchor by Liebig, Charlottesville, Virginia.
2. Sup-R-Set by U.S.E. Diamond, York, Pennsylvania.
3. HVA by Hilti, Tulsa, Oklahoma.
4. Parabond by Molly Division of U.S.M., Temple, Pennsylvania.

L. Paint-Shop Primer (Steel exposed to the elements)

1. Series 90-97 Urethane Zinc Primer by Tnemec Co.
2. Series 10-99 Alkyd Primer by Tnemec Co.

M. All Other Materials: Type best suited for the purpose intended. Follow manufacturer's recommendations.

2.2 DESIGN:

A. Connections

1. Design and detail all connections to resist the loads and reactions indicated on the Drawings or specified herein. Use details consistent with the details shown on the Drawings, supplementing where necessary. The details shown on the Drawings are conceptual and do not indicate the required weld sizes or number of bolts unless specifically noted. Use rational engineering design and standard practice in detailing, accounting for all loads and eccentricities in both the connection and the members. Promptly notify the Architect/Engineer of any location where the connection design criteria is not clearly indicated. The design of all connections is subject to the review and acceptance of the Architect/Engineer.
2. A combination of bolts and welds to transmit loads in the same faying surface is not permitted.
3. Use beam-to-column connections which minimize the eccentric loading on the column. Detail and fabricate unrestrained simple beam end connections to minimize end restraint of the beam. Design all parts of such connections (such as welds, bolts, and material) taking eccentricity into account.

2.3 FABRICATION:

A. General - Fabricate and assemble structural work in the shop to the greatest extent possible.

Fabricate and assemble in accordance with AISC Specifications and approved shop drawings. Before fabrication, straighten materials by methods that will not injure the steel. After punching or working component parts of a member, remove twists or bends.

B. Identification - Properly mark and match mark each structural steel member for position and identification. Use marks which agree with those shown on the Shop Drawings and Erection Drawings.

C. Camber - Fabricate all members with the natural camber up. Provide shop-induced camber for beams and girders as indicated.

D. Embedded Plate Headed Studs - Prepare steel surfaces as recommended by the manufacturer of the headed studs. Shop weld studs, spaced as shown, to the steel member. Use automatic end welding of the headed stud connectors in accordance with the manufacturer's printed instructions.

E. Welding

1. Use shielded metal arc welding, submerged arc welding, or flux core arc welding for all shop welding.
2. Perform all welding in compliance with the AWS "Structural Welding Code" using AWS qualified welders. The Architect/Engineer may require re-qualification of operators by tests prescribed in the AWS "Standard Qualification Procedures" for changes in welding procedure.
3. Remove paint, grease, loose scale and foreign matter from the surfaces to be welded. Clean the welds each time the electrode is changed or a new pass is started. Chip clean burned or flame cut edges before depositing welds.
4. Do not begin structural welding until joint elements are bolted or tacked in intimate contact and adjusted to the dimensions shown, with allowance for any weld shrinkage that is expected. Hold component parts of built-up members with clamps or other means to keep parts straight and in close contact. Take precautions to minimize "lock-up" stress and distortion due to heat.
5. Do not exceed a maximum space of 1/4 inch between pieces or members to be butt welded. Bevel pieces or members up to 3/8 inch thickness to form a single or double "Vee" before being welded. Bevel pieces over 3/8 inch thickness to form a double "Vee" whenever possible. Lay and size fillet welds as shown. Measure only the effective portion of fillet welds. Do not exceed a 1/16 inch maximum space between pieces or members to be fillet welded.
6. Welds not otherwise specified are continuous fillet welds. Use the minimum fillet size in accordance with AWS, but not less than 1/4 inch.
7. Weld heavy sections and those having a high degree of restraint with low hydrogen electrodes. Perform intermittent welding, continuous welding and straightening of

built-up sections to minimize internal stresses.

8. The same electrode may be used with various thicknesses of plate, but adjust the current used and the number of passes proportionately.
9. Do not weld in a wind unless wind protection is provided. Do not splice members without prior approval or review by the Architect/Engineer.
10. After being deposited, brush welds with wire brushes. Make welds which exhibit uniform section, smoothness of welded metal, feather edges without undercuts or overlays and which are free of porosity and clinkers. Visual inspection of the edges and ends of fillets and butt joint welds must indicate good fusion, with penetration into the base metal. Cut out and replace defective welds.

F. Cutting

1. Perform manual oxygen cutting only with a mechanically guided torch, except as permitted below:
   a. Gas cut edges which are not to be welded and which will be free of substantial stresses (as determined by the Architect/Engineer) may be cut manually with an unguided torch provided that specified AISC edge distances to holes are maintained.
   b. Gas cut edges which will be subjected to substantial stress (over 1/2 the allowable stress, as determined by the Architect/Engineer), or which are to be welded may be cut manually with an unguided torch to a line not within 1/8" of the finished dimension. Complete the final removal of material by chipping or grinding to produce a surface quality equal to that of the base metal edges.
2. Do not oxygen cut holes for bolted connections - components prepared in this manner will be rejected.
3. Shape all re-entrant corners notch-free to a radius of at least 1/2 inch.
4. Cut only those openings of the size and location shown on the reviewed Shop Drawings.

G. Punching, Drilling, and Reaming:

1. Material may be punched 1/16" larger than the nominal diameter of the bolts. Wherever the thickness of metal is greater than 7/8" or is greater than the diameter of the bolts plus 1/8", drill or subpunch holes and ream. The diameter for subpunched holes shall be 1/16" smaller than nominal diameter of bolt accommodated. Locate finished holes to insure passage of bolts through assembled materials without drifting. Enlarge holes to receive bolts by reaming. Remove burrs caused by punching or reaming before assembly of bolted joints or members.
2. Drill or punch holes at right angles to the surface of the metal. Do not make or enlarge holes by burning. Clean-cut holes without torn or ragged edges.
3. Punch and drill steel for attachment of other materials indicated on the Drawings or

noted in the Specifications to be attached to the steel. Use suitable templates for proper location of this work. Provide slotted holes for adjustment where indicated.

H. Finished Ends – Finish all column ends where loads are transferred by contact bearing.

I. High Strength Bolted Connections

1. Use bolts of a length that will extend at least 1/4" beyond the nuts in the completed connection. Enter bolts into the holes without damaging the thread.
2. Provide a calibrated bolt tension indicating device at the jobsite. Use the device to confirm the suitability both of the component parts of the fastener assembly and of the selected installation techniques. Tighten representative samples of each bolt type and size in the device to demonstrate both proper snug tight conditions and the additional tightening necessary to develop the bolt pretension prescribed in Table 8.1 of the RCSC "Specification." Use the device to insure that the installation wrenches and pneumatic supply are of adequate capacity.
3. Correct poor matching of holes by drilling hole to the next larger bolt size and using the larger size bolt, if approved by the Architect/Engineer.
4. Assemble joints without the use of separate erection bolts. Install bolts using powered impact wrenches of sufficient capacity and with an adequate supply of air.
5. Bring all plies of the connection into firm contact by tightening all bolts to a snug tight condition. Progress systematically from the most rigid portion of the joint out to the joint free edges. Retighten any bolts, which may have loosened during the assembly process. Protect bolt heads and nuts during assembly and tightening.
6. Tighten bolts in connections identified as tension or slip-critical connections to the pretension levels specified in Table 8.1 of the RCSC "Specification."

2.4 SUPPLEMENTAL FRAMING:

A. Provide supplemental framing at all openings as shown on the Drawings and at all suspended loads.

2.5 SHOP PAINTING:

A. Cleaning and Preparation

1. Painted Steel

a. Clean steel not exposed to the elements that is specified to be painted in accordance with SSPC-SP2. Steel not exposed to the elements is contained within the building envelope.
b. Clean steel exposed to the elements that is to be painted in accordance with SSPC-SP6. Connections are to be included.

B. Surfaces to be Painted:

1. Steel that is exposed to the elements and related connections are either painted or hot dipped galvanized.
2. Do not paint the following surfaces:
   a. Top surface of beams to receive metal deck and/or shear connectors fastened by welding.
   b. Contact surfaces of high strength slip-critical or tension bolted connections.
   c. Surfaces within 2" of field welds.
   d. Machine finished surfaces (e.g., bearing surfaces of columns and column base plates).

C. Surfaces to be Painted:

1. All steel surfaces, except as follows:
   a. Contact surfaces of high strength slip-critical or tension bolted connections.
   b. Surfaces within 2" of field welds.
   c. Machine finished surfaces (e.g., bearing surfaces of columns and column base plates).

D. Method and Rate of Paint Application:

1. Steel not exposed to the elements
   a. Apply one prime coat of paint to dry, clean surfaces by brush, spray, or roller. Do not allow paint to run or sag.
   b. Do not exceed a coverage rate per coat of 400 square feet per gallon providing a minimum dry film thickness of 2 mils.
   c. If, for any reason, any surface to be field welded is painted, remove the paint completely to within the stated limits before field welding. If high strength slip-critical bolted connection contact surfaces are painted, the allowable load per bolt used in design must be in accordance with the RCSC "Specification" value for the paint type used. If any machine finished surface is painted, remove the paint completely, and touch up the specified finish, if required, before shipping or erection.
2. Steel exposed to the elements
   a. Apply a single coat of Zinc Primer, minimum dry film thickness 3. mils, in strict conformance with the manufacturer's printed requirements.
   b. Steel will receive finish top coat(s) per Division 9.

PART 3 - EXECUTION

3.1 PREPARATION:

A. Employ the services of a Registered Surveyor to establish permanent bench marks and field verify the location and elevation of the following:

1. Anchor rods – verify both location and extension above substrate.
2. Concrete or masonry on which structural steel is to be placed.

B. Report any discrepancies to the Architect/Engineer. Do not proceed with erection until out of tolerance conditions are corrected to satisfaction of erector and Architect/Engineer.

C. Examine the substrates, adjoining construction, and conditions under which work is to be installed. Do not proceed with the work until unsatisfactory conditions detrimental to the proper and timely completion of the work have been corrected.

D. The design, strength, safety and adequacy of all temporary bracing and methods of construction are the responsibility of the Contractor. This responsibility includes the safety and stability of the structural steel work at all stages of erection, until the permanent lateral load resisting system of the structure becomes fully effective. No action by the Architect/Engineer will eliminate, lessen or restrict this responsibility in any manner.

3.2 ERECTION:

A. Set base plates and bearing plates level to correct elevations. Support plates temporarily on steel wedges, shims, leveling devices, or as shown on Drawings, until corresponding supported member has been positioned, plumbed and anchor-bolted. Leave protruding leveling devices in place until after the grout has been placed and has attained required strength; then cut off flush with the top or edges of the base plate, or both, except as otherwise noted.

B. Align, level and adjust all members accurately prior to final fastening. Clean all bearing surfaces and surfaces that will be in permanent contact prior to final assembly of the members. Use drift pins only to bring the parts together. Do not use drift pins in a manner that distorts or damages the metal.

C. As erection progresses, securely connect the work to safely resist all dead load, wind load and erection forces. Introduce temporary bracing wherever necessary to safely resist all loads to which the structure may be subjected, including erection equipment and its operation. Leave the temporary bracing in place for as long as is required for safety.

D. Do not perform oxygen cutting in the field without written permission from the Architect/Engineer. When permitted, execute in accordance with the requirements herein specified.

E. Install sliding connections of the design shown. Exercise particular care in erection to ensure the proper functioning of these connections as sliding joints.

F. Splice members only where shown or specified.

G. Provide all temporary supports, flooring, planking and scaffolding necessary in conjunction with the erection of the structural steel, or the support of erection equipment, as a part of the erection work. Use temporary floors as required by Federal, State, and Municipal Laws and governing safety regulations.

H. Field Welding

1. Use shielded metal arc welding or flux core arc welding for all field welding.
2. Provide safe and substantial work platforms at the proper height to permit the best possible field welding technique. Provide temporary enclosures, shielding, etc. to protect the welding operators and the joints to be welded against the elements during welding operations.
3. Perform welding in accordance with the requirements of Fabrication - Welding - in Part 2 - Products.

I. Installation of High Strength Bolts

1. Provide safe and substantial work platforms for bolting crews.
2. Assign an identification symbol or mark to each bolting crew working on the project. Use this identification on each joint completed.
3. Perform bolting in accordance with the requirements of Fabrication - High Strength Bolted Connections - in Part 2 - Products.

J. After erection, remove all loose mill scale, loose rust, oil, grease or other bond inhibiting foreign substances from steel to be fireproofed.

3.3 FABRICATION AND ERECTION TOLERANCES:

A. Unless otherwise noted, level and plumb individual members of the structure to an accuracy of 1 in 500, and erect structural steel to within the tolerances specified in the AISC "Code of Standard Practice." Base all leveling and plumbing on the mean operating temperature of the structure. Make allowances for the differences in temperature at time of erection and the mean temperature at which the structure will be at completion and in service. Base all measurements relating to tolerances on the theoretical centerline of the columns. In addition to the requirements listed above, plumb and align columns as follows:

1. All columns - within 1" of the theoretical centerline either toward or away from the building.
2. The centerline of any two (2) adjacent columns - within 3/4" of each other either toward or away from the building.
3. All intermediate exterior columns - within 3/4" of a line between the corner

columns.

3.4 FIELD SURVEYS:

A. Establish bench marks and survey the base structure for dimensional extremes before proceeding with erection to determine the range of any required compensating adjustments. Make an accurate survey of actual column locations, including vertical elevations, immediately upon the completion of every tier of steel. Promptly submit report to the Architect/Engineer. Include resurvey of tier below. Should column locations vary beyond the allowable tolerances, take necessary corrective measures, and modify details and/or procedures as required. Survey the final erected structural steel frame prior to the application of any other work, and report any discrepancies from Contract requirements to the Architect/Engineer.

3.5 CORRECTIVE WORK

A. Report to the Architect/Engineer any structural steel members or assemblages having fabrication or erection errors, or errors or deformations preventing proper assembly and fitting of parts.

B. Submit Drawings to the Architect/Engineer showing the reasons for and details of proposed corrective work. Perform the corrective work only after the Architect/Engineer has reviewed and accepted the corrective procedures. Perform any additional tests, at the Contractor's expense, that may be necessary to show compliance of corrected work.

3.6 FIELD TOUCH-UP PAINTING:

A. After erection, touch-up all exposed metal surfaces where the shop coat of paint is missing or has been damaged. Use the same type of paint as approved for the shop coat.

B. Thoroughly clean all areas to be painted to remove rust, dirt and weld slag prior to touch-up.

C. Extend the touch-up paint a minimum of 2" onto the undamaged finish.

D. Uniformly apply the paint to dry surfaces to a dry film thickness of no less than 2 mils (3 mils for steel exposed to the elements).

END OF SECTION 05120

SECTION 05500 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following metal fabrications:

1. Rough hardware.
2. Ship's ladders.
3. Ladder safety cages.
4. Ladders.
5. Loose bearing and leveling plates.
6. Miscellaneous framing and supports for the following:
   a. Applications where framing and supports are not specified in other sections.
7. Miscellaneous steel trim, including the following:
   a. Steel angle corner guards.
   b. Edgings.
8. Tread plate and supports.
9. Pipe guards.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 5 Section "Gratings" for metal gratings.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for steel plate, paint products, and grout.

C. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.

1. For installed products indicated to comply with design loads include structural analysis data signed by the qualified professional engineer responsible for their

preparation.

D. Samples representative of materials and finished products as may be requested by Architect.

E. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Firm experienced in producing metal fabrications similar to those indicated for this Project with a record of successful in-service performance, and with sufficient production capacity to produce required units without delaying the Work.

B. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel," AWS D1.2 "Structural Welding Code--Aluminum," and AWS D1.3 "Structural Welding Code--Sheet Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 PROJECT CONDITIONS

A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 FERROUS METALS

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Rolled Steel Floor Plates: ASTM A 786/A 786M.

D. Steel Tubing: Product type (manufacturing method) and as follows:

1. Cold-Formed Steel Tubing: ASTM A 500.
2. Hot-Formed Steel Tubing: ASTM A 501.

a. For exterior installations and where indicated, provide tubing with hot-dip galvanized coating per ASTM A 53.

E. Steel Pipe: ASTM A 53, standard weight (schedule 40), unless otherwise indicated, or another weight required by structural loads.

1. Galvanized finish unless otherwise indicated.

F. Gray-Iron Castings: ASTM A 48, Class 30.

G. Malleable-Iron Castings: ASTM A 47, Grade 32510 (ASTM A 47M, Grade 22010).

H. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as required, hot-dip galvanized per ASTM A 153.

I. Welding Rods and Bare Electrodes: Select according to AWS specifications for the metal alloy to be welded.

2.2 PAINT

A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

1. For all exterior steel framing and support elements, prepare and prime paint in accordance with manufacturers recommendations for zinc-rich primers equivalent to the following:

a. Series 90-97 Tneme Zinc Primer, Tnemec Co.
b. Chemtec 69 Zinc Rich Primer, Southern Coatings, Inc.
c. Zinc-Plate 49 Organic Primer, Conlux Coatings, Inc.

B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint 20.

C. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except

containing no asbestos fibers.

2.3 FASTENERS

A. General: Provide plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating, for exterior use or where built into exterior walls. Select fasteners for the type, grade, and class required.

2.4 GROUT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

B. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

1. Nonshrink, Nonmetallic Grouts:

a. Construction Grout; W. R. Bonsal Co.
b. Diamond-Crete Grout; Concrete Service Materials Co.
c. Supreme; Cormix Construction Chemicals.
d. Sure-grip High Performance Grout; Dayton Superior Corp.
e. Euco N-S Grout; Euclid Chemical Co.
f. Five Star Grout; Five Star Products.
g. Vibropruf #11; Lambert Corp.
h. Crystex; L & M Construction Chemicals, Inc.
i. Masterflow 928 and 713; Master Builders Technologies, Inc.
j. Sealtight 588 Grout; W. R. Meadows, Inc.
k. Sonogrout 14; Sonneborn Building Products--ChemRex, Inc.
l. Kemset; The Spray-Cure Company.

2.5 FABRICATION, GENERAL

A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

C. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal

assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.

1. Temperature Change (Range): 180 deg F .

D. Shear and punch metals cleanly and accurately. Remove burrs.

E. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

F. Remove sharp or rough areas on exposed traffic surfaces.

G. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

H. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

K. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

L. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.6 ROUGH HARDWARE

A. Furnish bent, or otherwise custom-fabricated, bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 6 Sections.

B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts that bear on wood structural connections, and furnish steel washers elsewhere.

2.7 STEEL LADDERS

A. General: Fabricate ladders for the locations shown, with dimensions, spacings, details, and anchorages as indicated. Comply with requirements of ANSI A14.3.

B. Siderails: Continuous, steel, 1/2-by-2-1/2-inch flat bars, with eased edges, spaced 18 inches apart.

C. Rungs: Open steel grating treads: 2-1/2 in. x 3/4 in.

D. Fit rungs centered in side rails, weld and grind smooth on exposed edges.

E. Support each ladder at top and bottom and at intermediate points spaced not more than 5 feet (1.5 m) o.c. with welded or bolted steel brackets.

1. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches (180 mm).
2. Extend side rails 42 inches (1.1 m) above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.

F. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to the rung by a proprietary process.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a. Mebac, IKG Borden.
b. SLIP-NOT, W. S. Molnar Co.

G. Galvanize ladders, including brackets and fasteners.

2.8 LADDER SAFETY CAGES

A. General: Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or riveting.

B. Primary Hoops: 5/16-by-4-inch (8-by-100-mm) steel bars for top and bottom hoops; and for cages longer than 20 feet (6 m), intermediate hoops spaced not more than 20 feet (6 m) o.c.

C. Secondary Intermediate Hoops: 5/16-by-2-inch (8-by-50-mm) steel bar hoops spaced not more than 4 feet (1.2 m) o.c. between primary hoops.

D. Vertical Bars: 5/16-by-2-inch (8-by-50-mm) steel bars secured to each hoop, spaced approximately 9 inches (230 mm) o.c.

E. Fasten assembled safety cage to ladder rails and adjacent construction as indicated.

F. Galvanize ladder safety cages, including fasteners.

2.9 SHIP'S LADDERS

A. Provide 75-degree ship's ladders where indicated. Fabricate of open type construction with structural steel channel or steel plate stringers, steel pipe handrails, and open steel grating treads, unless otherwise indicated. Provide brackets and fittings for installation.

B. Galvanize ship's ladders, including brackets and fasteners.

2.10 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of the required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.

2.11 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports for applications indicated that are not a part of structural steel framework as required to complete the Work.

B. Fabricate units to sizes, shapes, and profiles indicated and required to receive other adjacent construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.

a. Except as otherwise indicated, space anchors 24 inches (600 mm) o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches (32

mm) wide by 1/4 inch (6 mm) thick by 8 inches (200 mm) long.

C. Galvanize miscellaneous framing and supports.

2.12 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from structural steel shapes, plates, and bars of profiles shown with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices wherever possible.

B. Provide cutouts, fittings, and anchorages as required to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches (150 mm) from each end, 6 inches (150 mm) from corners, and 24 inches (600 mm) o.c., unless otherwise indicated.

C. Galvanize miscellaneous steel trim in the following locations:

1. Exterior locations.

2.13 FLOOR PLATE

A. Fabricate raised-pattern floor plates from rolled-steel floor plate of thickness and in pattern indicated below:

1. Thickness: 3/16 inch (4.8 mm).
2. Pattern: No. 1.

B. Include steel angle stiffeners, and fixed and removable sections as indicated.

2.14 PIPE GUARDS

A. Provide pipe guards where indicated of 3-by-3-by-5/16-inch (76-by-76-by-8-mm) steel angles, extending from floor to 3 feet 6 inches (1.1 m) above floor. Provide with 3/8-inch (10-mm) steel base plates for bolting to floor, and with 1/4-by-2-inch (6.4-by-50-mm) steel strap braces at top. Provide at least 2 vertical angles at each location, except at internal corners, and extend strap between angles and from each angle to wall or column.

2.15 PIPE BOLLARDS

A. Fabricate pipe bollards from Schedule 40 steel pipe. Cap bollards with ¼-inch (6.5-mm) minimum steel plate.

B. Fabricate sleeves for bollard anchorage from steel pipe with 1/4-inch- (6.4-mm-) thick steel plate welded to bottom of sleeve.

2.16 FINISHES, GENERAL

A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designing finishes.

B. Finish metal fabrications after assembly.

2.17 STEEL AND IRON FINISHES

A. Galvanizing: For those items indicated for galvanizing, apply zinc coating by the hot-dip process complying with the following requirements:

1. ASTM A 153 for galvanizing iron and steel hardware.
2. ASTM A 123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch (0.76 mm) thick or thicker.

B. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B): SSPC-SP 6 "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 3 "Power Tool Cleaning."

C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes or to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA 1 "Paint Application Specification No. 1" for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

B. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.2 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction. Include

threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.

3.3 SETTING LOOSE PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.

B. Set loose leveling and bearing plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.

1. Use nonshrink, metallic grout in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations, unless otherwise indicated.

2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 INSTALLING PIPE GUARDS

A. Install pipe guards at exposed pipes where not protected by curbs or other barriers. Install by bolting to floor and wall or column with drilled-in expansion anchors.

3.5 INSTALLING PIPE BOLLARDS

A. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. After bollards have been inserted into sleeves, fill annular space between bollard and sleeve solidly with nonshrink, nonmetallic grout, mixed and placed to comply with grout manufacturer's directions.

B. Fill bollards solidly with concrete, mounding top surface.

3.6 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a 2.0-mil (0.05-mm) minimum dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of the shop paint on miscellaneous metal is specified in Division 9 Section "Painting."

C. For galvanized surfaces, clean welds, bolted connections, and abraded areas, and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 05500

SECTION 05530 - GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Metal bar gratings.
2. Expanded-metal gratings.
3. Metal frames and supports for gratings.

B. Related Sections include the following:

1. Division 5 Section "Structural Steel" for structural-steel framing system components.
2. Division 5 Section "Metal Fabrications" for grating treads and landings of steel-framed stairs.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance of Gratings: Provide gratings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Floors, Walkways and Elevated Platforms: Uniform load of 250 lbf/sq. ft. or concentrated load of 3000 lbf, whichever produces the greater stress.
2. Limit deflection to L/240 or 1/4 inch, whichever is less.

B. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads.".

1.4 SUBMITTALS

A. Product Data: For the following:

1. Formed-metal plank gratings.

2. Clips and anchorage devices for gratings.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Provide templates for anchors and bolts specified for installation under other Sections.
2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding certificates.

D. Qualification Data: For professional engineer.

1.5 QUALITY ASSURANCE

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual" and NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.6, "Structural Welding Code--Stainless Steel."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating gratings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

1.7 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Metal Bar Gratings:

a. Alabama Metal Industries Corporation.
b. All American Grating, Inc.
c. Barnett/Bates Corp.
d. Borden Metal Products (Canada) Limited.
e. Fisher & Ludlow.
f. Grupo Metelmex, S.A. de C.V.
g. IKG Industries; a Harsco Company.
h. Marwas Steel Co.; Laurel Steel Products Division.
i. Ohio Gratings, Inc.
j. Seidelhuber Metal Products, Inc.
k. Tru-Weld.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Wire Rod for Grating Crossbars: ASTM A 510.

C. Galvanized Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 33, with G90 coating.

D. Expanded Metal, Galvanized Steel: ASTM F 1267, Class 2, Grade A.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1 (A1).

D. Plain Washers: Round, ASME B18.22.1.

E. Lock Washers: Helical, spring type, ASME B18.21.1.

F. Anchors: Provide cast-in-place chemical or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material for Anchors in Exterior Locations: Alloy Group 1 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is welded.

B. Shop Primers: Provide primers that comply with Division 9 Painting Section.

C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Zinc-Rich Primer: Zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
3. Products: Subject to compliance with requirements, provide one of the following:

   a. Benjamin Moore & Co.; Epoxy Zinc-Rich Primer CM18/19.
   b. Carboline Company; Carbozinc 621.
   c. ICI Devoe Coatings; Catha-Coat 313.
   d. International Coatings Limited; Interzinc 315 Epoxy Zinc-Rich Primer.

e. PPG Architectural Finishes, Inc.; Aquapon Zinc-Rich Primer 97-670.
f. Sherwin-Williams Company (The); Corothane I GalvaPac Zinc Primer.
g. Tnemec Company, Inc.; Tneme-Zinc 90-97.

E. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates for attaching in the field.
2. Toeplate Height: 4 inches, unless otherwise indicated.

2.6 METAL BAR GRATINGS

A. Welded Steel Grating

1. Bearing Bar Spacing: 1-3/16 inches.

2. Bearing Bar Depth: As required to comply with structural performance requirements.
3. Bearing Bar Thickness: As required to comply with structural performance requirements.
4. Crossbar Spacing: 4 inches o.c.
5. Traffic Surface: Plain
6. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

B. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

C. Do not notch bearing bars at supports to maintain elevation.

2.7 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

2.8 STEEL FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish gratings, frames, and supports after assembly.

C. Galvanizing: For those items indicated for galvanizing, apply zinc coating by the hot-dip process complying with ASTM A 123/A 123M.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

E. Apply shop primer to uncoated surfaces of gratings, frames, and supports, except those with galvanized finishes and those to be embedded in concrete or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 INSTALLING EXPANDED-METAL GRATINGS

A. General: Comply with manufacturer's written instructions for installing gratings.

B. Place units with straight edge of bond up and with long direction of diamond-shaped openings parallel to direction of span.

C. Attach removable units to supporting members by bolting at 6-inch intervals.

D. Attach nonremovable units to supporting members by welding, unless otherwise indicated. Space welds at 6-inch intervals.

E. Attach aluminum units to steel supporting members by bolting at 6-inch intervals.

F. Butt edges parallel to long direction of diamond-shaped openings and weld at every second bond point. Place individual grating sections so diamonds of one piece are aligned with those of adjacent sections.

3.4 INSTALLING METAL PLANK GRATINGS

A. General: Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard anchor clips and hold-down devices for bolted connections.

B. Attach removable units to supporting members by bolting at every point of contact.

C. Attach nonremovable units to supporting members by welding, unless otherwise indicated. Comply with manufacturer's written instructions for size and spacing of welds.

D. Attach aluminum units to steel supporting members by bolting at side channels at every point of contact and by bolting intermediate planks at each end on alternate sides. Bolt adjacent planks together at midspan.

3.5 INSTALLING GLASS-FIBER-REINFORCED PLASTIC GRATINGS

A. Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard stainless-steel anchor clips and hold-down devices for bolted connections.

3.6 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05530

SECTION 08111 - STANDARD STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following labeled, two-hour fire-rated assemblies:

1. Standard single leaf hollow-metal steel doors and hardware.
2. Standard hollow-metal steel frames.

B. Related Sections include the following:

1. Division 9 painting Sections for field painting standard steel doors and frames.
2. Division 13 metal building systems Section for doors provided as part of pre-engineered metal building system.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, core descriptions, label compliance, fire-resistance and temperature-rise ratings, and finishes for each type of steel door and frame specified.

B. Shop Drawings: In addition to requirements below, provide a schedule of standard steel doors and frames using same reference numbers for details and openings as those on Drawings:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details.
3. Frame details for each frame type, including dimensioned profiles.
4. Details and locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.

6. Details of anchorages, accessories, joints, and connections.

C. Coordination Drawings: Drawings of each size and type of opening, including door and frame, drawn to scale and coordinating door hardware. Show elevations of each door design type, showing dimensions, locations of door hardware.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.

E. Qualification Data: For Installer.

F. Product Test Reports: Based on evaluation of comprehensive fire tests performed by a qualified testing agency, for each type of standard steel door and frame.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.

C. Source Limitations: Obtain standard steel doors and frames through one source from a single manufacturer.

D. Fire-Rated Door Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated.

1. Test Pressure: Test according to NFPA 252 or UL 10C. After 5 minutes into the test, the neutral pressure level in furnace shall be established at 40 inches or less above the sill.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch- high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.

1. If wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate installation of anchorages for standard steel frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amweld Building Products, LLC.
2. Benchmark Doors; a division of General Products Co., Inc.
3. Ceco Door Products; an ASSA ABLOY Group Company.
4. CURRIES Company; an ASSA ABLOY Group Company.
5. Deansteel Manufacturing, Inc.
6. Fleming Door Products Ltd.; an ASSA ABLOY Group Company.
7. Kewanee Corporation (The).
8. Mesker Door Inc.
9. Pioneer Industries, Inc.
10. Republic Builders Products Company.
11. Steelcraft; an Ingersoll-Rand Company.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching standard steel door frames of type indicated.

C. Grout: Comply with ASTM C 476, with a slump of 4 inches for standard steel door frames built into concrete or masonry, as measured according to ASTM C 143/C 143M.

D. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-developed indexes of 25 and 50 respectively; passing ASTM E 136 for combustion characteristics.

E. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD STEEL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces, unless otherwise indicated. Comply with ANSI A250.8.

1. Design: Flush panel.

   a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

2. Vertical Edges for Single-Acting Doors: Beveled edge

   a. Beveled Edge: 1/8 inch in 2 inches.

3. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- thick end closures or channels of same material as face sheets.
4. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Interior Doors: Face sheets fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior door requirements. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:

1. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 Full Flush 2 Seamless.

C. Hardware Reinforcement: Fabricate reinforcement plates from same material as door face sheets to comply with the following minimum sizes:

1. Hinges: Minimum 0.123 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
2. Lock Face, Closers, and Concealed Holders: Minimum 0.067 inch thick.
3. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick.

D. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

E. Hardware: Provide hinges, closer, threshold, smoke gasket as required, lockset, silencers and keying to match existing interior doors.

2.4 STANDARD STEEL FRAMES

A. General: Comply with ANSI A250.8 and with details indicated for type and profile.

B. Interior Frames: Fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior frame requirements.

1. Fabricate frames with mitered or coped and welded face corners and seamless face joints, unless otherwise indicated.
2. Frames for Level 2 Steel Doors: 0.053-inch- thick steel sheet, unless otherwise indicated.

C. Hardware Reinforcement: Fabricate reinforcement plates from same material as frames to comply with the following minimum sizes:

1. Hinges: Minimum 0.123 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
2. Lock Face**,** Closers, and Concealed Holders: Minimum 0.067 inch thick.
3. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick.

D. Supports and Anchors: Fabricated from electrolytic zinc-coated or metallic-coated steel sheet.

E. Jamb Anchors:

1. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

F. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

G. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.5 FABRICATION

A. General: Fabricate standard steel doors and frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Standard Steel Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners, unless otherwise indicated.
3. Where installed in masonry, leave vertical mullions in frames open at top for grouting.
4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
5. Jamb Anchors: Provide number and spacing of anchors as follows:
   a. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Provide plastic plugs to keep holes clear during construction.

   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

C. Hardware Preparation: Factory prepare standard steel doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section "Door Hardware."

1. Reinforce doors and frames to receive nontemplated mortised and surface-mounted door hardware.
2. Comply with applicable requirements in ANSI A250.6 and ANSI/DHI A115 Series specifications for door and frame preparation for hardware. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

2.6 STEEL FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish standard steel door and frames after assembly.

B. Steel Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel; comply with SSPC-SP 3, "Power Tool Cleaning," or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

2. Color and Gloss: Color as selected by Architect from manufacturer's full range, in gloss level to match existing doors and frames in vicinity.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of standard steel doors and frames.

1. Examine roughing-in for embedded and built-in anchors to verify actual locations of standard steel frame connections before frame installation.
2. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work, if any are observed.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory.

B. Prior to installation and with installation spreaders in place, adjust and securely brace standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Provide doors and frames of sizes, thicknesses, and designs indicated. Install standard steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Standard Steel Frames: Install standard steel frames for doors and other openings, of size and profile indicated. Comply with SDI 105.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-protection-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install door silencers in frames before grouting.
    d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    e. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors.
3. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

4. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
5. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
6. Installation Tolerances: Adjust standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Standard Steel Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including standard steel doors or frames that are warped, bowed, or otherwise unacceptable.

B. Clean grout and other bonding material off standard steel doors and frames immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

END OF SECTION 08111

SECTION 09912 - PAINTING (PROFESSIONAL LINE PRODUCTS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.

1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

B. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.

1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Prefinished items include the following factory-finished components:

a. Finished mechanical and electrical equipment.
b. Light fixtures.
c. Prefinished roof accessories.
d. Fire-protection specialties.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:

a. Foundation spaces.
b. Utility tunnels.
c. Pipe spaces.

d. Duct shafts.

3. Finished metal surfaces include the following:

a. Prepainted metallic-coated steel sheet.
b. Stainless steel, except for fasteners indicated to match adjacent painted finish.
c. Chromium plate.
d. Copper and copper alloys.
e. Bronze and brass.

4. Operating parts include moving parts of operating equipment and the following:

a. Valve and damper operators.
b. Linkages.
c. Sensing devices.
d. Motors, motor and fan shafts, and fan blades.

5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Do not paint:

1. Split-faced, ground-faced, and prefaced sides of concrete unit masonry.

E. Related Sections include the following:

1. Division 5 Section "Structural Steel" for shop priming structural steel.
2. Division 5 Section "Metal Fabrications" for shop priming ferrous metal.
3. Division 8 Section "Steel Doors and Frames" for factory priming steel doors and frames.

1.3 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
3. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.
4. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

1.4 SUBMITTALS

A. Product Data: For each paint system indicated. Include block fillers and primers.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

B. Samples for Initial Selection: Where not already scheduled, furnish samples for each type of finish-coat material indicated.

1. After color selection, Architect will furnish color chips for surfaces to be coated.

C. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.

1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
3. Submit Samples on the following substrates for Architect's review of color and texture only:
   a. Ferrous Metal: 4-inch-square Samples of flat metal and 6-inch-long Samples of linear metal for each color and finish.

D. Qualification Data: For Applicator.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

C. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample for each type of coating and substrate required. Comply with procedures specified in PDCA P5. Duplicate finish of approved sample Submittals.

1. Architect will select one surface to represent surfaces and conditions for application of each type of coating and substrate.

    a. Wall Surfaces: Provide samples on at least 100 sq. ft..
    b. Small Areas and Items: Architect will designate items or areas required.

2. Apply benchmark samples, according to requirements for the completed Work, after permanent lighting and other environmental services have been activated. Provide required sheen, color, and texture on each surface.

    a. After finishes are accepted, Architect will use the room or surface to evaluate coating systems of a similar nature.

3. Final approval of colors will be from benchmark samples.

D. For interior work, use only paint rated as Class A interior finish in accordance with ASTM E 84, with a flame spread index of 0-25 and a smoke developed value not exceeding 450.

E. Paint and paint application is to comply with OSHA, EPA, and FDA regulations regarding VOC's, lead paint exposure and removal, paint disposal, paint storage, and ventilation.

F. Use paint of quality no less than manufacturer's best quality, based on accepted industry categories of Good, Better, Best regarding volume of solids content.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain storage containers in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.

1.7 PROJECT CONDITIONS

A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F.

B. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 deg F.

C. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.8 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.

1. Quantity: Furnish Owner with an additional 3-percent, but not less than 1 gal., of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

B. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Benjamin Moore & Co. (Benjamin Moore).
2. Duron Paints/Duron, Inc. (Duron) www.duron.comIn
3. ICI Paint Stores, Inc. (Dulux Paint).
4. M. A. Bruder & Sons, Inc. (M. A. B. Paint).
5. PPG Industries, Inc. (Pittsburgh Paints).
6. Sherwin-Williams Co. (Sherwin-Williams).

2.2 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. Colors: Match Architect's samples.

2.3 EXTERIOR PRIMERS

A. Exterior Ferrous-Metal Primer: Factory-formulated rust-inhibitive metal primer for exterior application.

1. Benjamin Moore; Moore's IMC Alkyd Metal Primer No. M06: Applied at a dry film thickness of not less than 2.0 mils.
2. Dulux Paint; 4160-XXXX Devguard Multi-Purpose Tank & Structural Primer. Applied at a dry film thickness of not less than 2.0 mils.
3. Duron; Dura Clad Universal Phenolic Alkyd Metal Primer 33-042: Applied at a dry film thickness of not less than 2.4 mils.
4. M. A. B. Paint; Rust-O-Lastic Anti-Corrosive Primer 073-132: Applied at a dry film thickness of not less than 2.0 mils.
5. Pittsburgh Paints; 90-712 Pitt-Tech One Pack Interior/Exterior Primer Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils.
6. Sherwin-Williams; Kem Kromik Universal Metal Primer B50NZ6/B50WZ1: Applied at a dry film thickness of not less than 3.0 mils.

B. Exterior Galvanized Metal Primer: Factory-formulated galvanized metal primer for exterior application.

1. Benjamin Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils.
2. Dulux Paint; 4160-XXXX Devguard Multi-Purpose Tank & Structural Primer: Applied at a dry film thickness of not less than 2.0 mils.
3. Duron; Dura Clad Acrylic Galvanized Metal Primer 33-100: Applied at a dry film thickness of not less than 1.4 mils.

4. M. A. B. Paint; Rust-O-Lastic Hydro-Prime II Acrylic (DTM) Maintenance Primer 073-189: Applied at a dry film thickness of not less than 2.0 mils.
5. Pittsburgh Paints; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils.
6. Sherwin-Williams; Galvite HS Paint B50WZ3: Applied at a dry film thickness of not less than 2.0 mils.

2.4 INTERIOR PRIMERS

A. Interior Gypsum Board Primer: Factory-formulated latex-based primer for interior application.

1. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils.
2. Dulux Paint; 1000-1200 Dulux Ultra Basecoat Interior Latex Wall Primer: Applied at a dry film thickness of not less than 1.2 mils.
3. Duron; Interior Latex Drywall Primer 04-124: Applied at a dry film thickness of not less than 1.6 mils.
4. M. A. B. Paint; Fresh Kote Vinyl Primer 037-100: Applied at a dry film thickness of not less than 1.5 mils.
5. Pittsburgh Paints; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil.
6. Sherwin-Williams; PrepRite 200 Latex Wall Primer B28W200 Series: Applied at a dry film thickness of not less than 1.6 mils.

B. Interior Ferrous-Metal Primer: Factory-formulated quick-drying rust-inhibitive alkyd-based metal primer.

1. Benjamin Moore; Moore's IMC Alkyd Metal Primer No. M06: Applied at a dry film thickness of not less than 2.0 mils.
2. Dulux Paint; 4160-6130 Devguard Multi-Purpose Tank & Structural Primer: Applied at a dry film thickness of not less than 2.0 mils.
3. Duron; Dura Clad Universal Phenolic Alkyd Metal Primer 33-042: Applied at a dry film thickness of not less than 2.4 mils.
4. M. A. B. Paint; Rust-O-Lastic Anti-Corrosive Primer 073-132: Applied at a dry film thickness of not less than 2.0 mils.
5. Pittsburgh Paints; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 1.5 mils.
6. Sherwin-Williams; Kem Kromik Universal Metal Primer B50NZ6/B50WZ1: Applied at a dry film thickness of not less than 3.0 mils.

2.5 EXTERIOR FINISH COATS

A. Exterior Full-Gloss Alkyd Enamel: Factory-formulated full-gloss alkyd enamel for exterior application.

1. Benjamin Moore; Moore's IMC Urethane Alkyd Enamel M22: Applied at a dry film thickness of not less than 2.0 mils.
2. Dulux Paint; 4308-XXXX Devguard Alkyd Industrial Gloss Enamel: Applied at a dry film thickness of not less than 2.0 mils.
3. Duron; Dura Clad Alkyd Gloss Enamel Urethane Modified 12-Series: Applied at a dry film thickness of not less than 1.4 mils.
4. M. A. B. Paint; Rust-O-Lastic Finish Coating 074 Line: Applied at a dry film thickness of not less than 2.0 mils.
5. Pittsburgh Paints; 7-814 Pittsburgh Paints Industrial Gloss-Oil Interior/Exterior Enamel: Applied at a dry film thickness of not less than 1.5 mils.
6. Sherwin-Williams; Industrial Enamel B-54 Series: Applied at a dry film thickness of not less than 2.0 mils.

2.6 INTERIOR FINISH COATS

A. Interior Flat Acrylic Paint: Factory-formulated flat acrylic-emulsion latex paint for interior application.

1. Benjamin Moore; Moorecraft Super Spec Latex Flat No. 275: Applied at a dry film thickness of not less than 1.2 mils.
2. Dulux Paint; 1200-XXXX Dulux Professional Velvet Matte Interior Flat Latex Wall & Trim Finish: Applied at a dry film thickness of not less than 1.4 mils.
3. Duron; Ultra Deluxe Interior Acrylic Latex Flat 44-Series: Applied at a dry film thickness of not less than 1.3 mils.
4. M. A. B. Paint; Fresh Kote Latex Flat 402 Line: Applied at a dry film thickness of not less than 1.5 mils.
5. Pittsburgh Paints; 6-70 Line SpeedHide Interior Wall Flat-Latex Paint: Applied at a dry film thickness of not less than 1.0 mil.
6. Sherwin-Williams; ProMar 200 Interior Latex Flat Wall Paint B30W200 Series: Applied at a dry film thickness of not less than 1.4 mils.

B. Interior Flat Latex-Emulsion Size: Factory-formulated flat latex-based interior paint.

1. Benjamin Moore; Moorecraft Super Spec Latex Flat No. 275: Applied at a dry film thickness of not less than 1.2 mils.
2. Dulux Paint; 1200-XXXX Dulux Professional Velvet Matte Interior Flat Latex Wall & Trim Finish: Applied at a dry film thickness of not less than 1.4 mils.
3. Duron; Ultra Deluxe Interior Acrylic Latex Flat 44-Series: Applied at a dry film thickness of not less than 1.3 mils.

4. M. A. B. Paint; Fresh Kote Latex Flat 402 Line: Applied at a dry film thickness of not less than 1.5 mils.
5. Pittsburgh Paints; 6-70 Line SpeedHide Interior Wall Flat-Latex Paint: Applied at a dry film thickness of not less than 1.0 mil.
6. Sherwin-Williams; ProMar 200 Interior Latex Flat Wall Paint B30W200 Series: Applied at a dry film thickness of not less than 1.4 mils.

C. Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel.

1. Benjamin Moore; Moorcraft Super Spec Latex Eggshell Enamel No. 274: Applied at a dry film thickness of not less than 1.3 mils.
2. Dulux Paint; 1402-XXXX Dulux Professional Acrylic Eggshell Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.4 mils.
3. Duron; Ultra Deluxe Interior Acrylic Latex Eggshell Enamel 36-Series: Applied at a dry film thickness of not less than 1.4 mils.
4. M. A. B. Paint; Fresh Kote Latex Satin Eggshell Enamel 405 Line: Applied at a dry film thickness of not less than 1.5 mils.
5. Pittsburgh Paints; 6-400 Series SpeedHide Eggshell Acrylic Latex Enamel: Applied at a dry film thickness of not less than 1.25 mils.
6. Sherwin-Williams; ProMar 200 Interior Latex Egg-Shell Enamel B20W200 Series: Applied at a dry film thickness of not less than 1.6 mils.

D. Interior Semigloss Acrylic Enamel: Factory-formulated semigloss acrylic-latex enamel for interior application.

1. Benjamin Moore; Moorcraft Super Spec Latex Semi-Gloss Enamel No. 276: Applied at a dry film thickness of not less than 1.2 mils.
2. Dulux Paint; 1406-XXXX Dulux Professional Acrylic Semi-Gloss Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.5 mils.
3. Duron; Ultra Deluxe Interior Acrylic Latex Semi-Gloss Enamel 35-Series: Applied at a dry film thickness of not less than 1.4 mils.
4. M. A. B. Paint; Fresh Kote Latex Semi-Gloss 410 Line: Applied at a dry film thickness of not less than 1.5 mils.
5. Pittsburgh Paints; 6-500 Series SpeedHide Interior Semi-Gloss Latex: Applied at a dry film thickness of not less than 1.0 mil.
6. Sherwin-Williams; ProMar 200 Interior Latex Semi-Gloss Enamel B31W200 Series: Applied at a dry film thickness of not less than 1.3 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application. Comply with procedures specified in PDCA P4.

1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.2 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove and reprime.
2. Cementitious Materials: Prepare concrete, concrete unit masonry, and cement plaster surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and

burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.

3. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.

    a. Blast steel surfaces clean as recommended by paint system manufacturer and according to SSPC-SP 6/NACE No. 3.
    b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
    c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.

4. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Paint colors, surface treatments, and finishes are indicated in finish schedules.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in

place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.

5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
9. Sand lightly between each succeeding enamel coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer over metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces.

F. Mechanical items to be painted include, but are not limited to, the following when located in finished areas:

1. Uninsulated metal piping.
2. Pipe hangers and supports.
3. Tanks that do not have factory-applied final finishes.
4. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
5. Duct, equipment, and pipe insulation having "all-service jacket" or other paintable jacket material.
6. Mechanical equipment that is indicated to have a factory-primed finish for field painting.

G. Electrical items to be painted include, but are not limited to, the following:

1. Switchgear.
2. Panelboards.
3. Electrical equipment that is indicated to have a factory-primed finish for field painting.

H. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

I. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

J. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 CLEANING

A. Daily: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.

B. After completing painting in each room, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

3.5 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.

1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.6 EXTERIOR PAINT SCHEDULE

A. Items inside the Pump House are to be painted according to the Exterior Paint Schedule.

B. Ferrous Metal: Provide the following finish systems over piping, piping supports and exterior ferrous metal. Primer is not required on shop-primed items.

1. Full-Gloss Alkyd-Enamel Finish: Two finish coats over a rust-inhibitive primer.

a. Primer: Exterior ferrous-metal primer.
b. Finish Coats: Exterior full-gloss alkyd enamel.

C. Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated metal surfaces:

1. Full-Gloss Alkyd-Enamel Finish: Two finish coats over a galvanized metal primer.

a. Primer: Exterior galvanized metal primer.
b. Finish Coats: Exterior full-gloss alkyd enamel.

3.7 INTERIOR PAINT SCHEDULE

A. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces as required to match existing painted surfaces disturbed by the provision of access doors into existing interior shaft:

1. Flat Acrylic Finish - Ceilings and Soffits, General Use: One finish coat over a primer.

a. Primer: Interior gypsum board primer.
b. Finish Coat: Interior flat acrylic paint.

2. Low-Luster Acrylic-Enamel Finish - Walls: Two finish coats over a primer.

    a. Primer: Interior gypsum board primer.
    b. Finish Coats: Interior low-luster acrylic enamel.

B. Ferrous Metal: Provide the following finish systems over ferrous metal doors and frames:

1. Acrylic-Enamel Finish: Two finish coats, of gloss level to match existing doors and frames, over a primer.

    a. Primer: Interior ferrous-metal primer.
    b. Finish Coats: Interior acrylic enamel.

C. Zinc-Coated Metal: Provide the following finish systems over interior zinc-coated metal surfaces:

1. Acrylic-Enamel Finish: Two finish coats over a primer.

    a. Primer: Interior zinc-coated metal primer.
    b. Finish Coats: Interior acrylic enamel.

D. All-Service Jacket over Insulation: Provide the following finish system on cotton or canvas insulation covering:

1. Flat Acrylic Finish: Two finish coats. Add fungicidal agent to render fabric mildew proof.

    a. Finish Coats: Interior flat latex-emulsion size.

END OF SECTION 09912

SECTION 13125 - METAL BUILDING SYSTEMS

GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes metal building systems that consist of integrated sets of mutually dependent components including structural framing, roof panels, both removable-area and fixed wall panels, soffit panels, doors, sealant joints and accessories.

B. Related Sections include the following:

1. Division 3 Section "Cast-in-Place Concrete" for concrete foundations, slabs, and anchor-bolt installation.

1.3 DEFINITIONS

A. Bay: Dimension between main frames measured normal to frame (at centerline of frame) for interior bays, and dimension from centerline of first interior main frame measured normal to end wall (outside face of end-wall girt) for end bays.

B. Building Length: Dimension of the building measured perpendicular to main framing from end wall to end wall (outside face of girt to outside face of girt).

C. Building Width: Dimension of the building measured parallel to main framing from sidewall to sidewall (outside face of girt to outside face of girt).

D. Clear Span: Distance between supports of beams, girders, or trusses (measured from lowest level of connecting area of a column and a rafter frame or knee).

E. Eave Height: Vertical dimension from finished floor to eave (the line along the sidewall formed by intersection of the planes of the roof and wall).

F. Clear Height under Structure: Vertical dimension from finished floor to lowest point of any part of primary or secondary structure, not including crane supports, located within clear span.

G. Terminology Standard: Refer to MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

1.4 SYSTEM DESCRIPTION

A. General: Provide a complete, integrated set of metal building system manufacturer's standard mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Include primary and secondary framing, metal roof panels, metal wall panels, and accessories complying with requirements indicated.

1. Provide metal building system of size and with spacings, slopes, and spans indicated.

B. Primary Frame Type:

1. Rigid Clear Span: Solid-member, structural-framing system without interior columns.

C. End-Wall Framing: Manufacturer's standard for buildings not required to be expandable, consisting of primary frame, capable of supporting one-half of a bay design load, and end-wall columns.

D. Secondary Frame Type: Manufacturer's standard purlins and joists and flush-framed girts.

E. Eave Height: Manufacturer's standard height, as indicated by nominal height on Drawings.

F. Bay Spacing: Entire building to be column-free in both directions.

G. Roof Slope: 1/4 inch per 12 inches, minimum.

H. Roof System: Manufacturer's standard trapezoidal-rib standing-seam metal roof panels.

I. Exterior Wall System: Manufacturer's standard field-assembled, uninsulated metal wall panels.

1.5 SYSTEM PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal building systems capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Engineer metal building systems according to procedures in MBMA's "Metal Building Systems Manual."
2. Design Loads: As indicated on Drawings. Allow for unbalanced and snow drift loads.

3. Live Loads: Include vertical loads induced by the building occupancy indicated on Drawings. Include loads induced by maintenance workers, materials, and equipment for roof live loads.

    a. Building Occupancy: Utility – U.

4. Collateral Loads: Include additional dead loads other than the weight of metal building system for permanent items such as piping and sprinkler lines, mechanical systems, electrical systems.
5. Load Combinations: Design metal building systems to withstand the most critical effects of load factors and load combinations as required by I.B.C.
6. Deflection Limits: Engineer assemblies to withstand design loads with deflections no greater than the following:

    a. Purlins and Rafters: Vertical deflection of 240 of the span.
    b. Girts: Horizontal deflection of 240 of the span.
    c. Metal Roof Panels: Vertical deflection of 240 of the span.
    d. Metal Wall Panels: Horizontal deflection of 240 of the span.

7. Design secondary framing system to accommodate deflection of primary building structure and construction tolerances, and to maintain clearances at openings.
8. Provide metal panel assemblies capable of withstanding the effects of loads and stresses indicated, based on testing according to ASTM E 1592.

B. Seismic Performance: Design and engineer metal building systems capable of withstanding the effects of earthquake motions determined according to the 2003 IBC.

C. Thermal Movements: Provide metal panel systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

    1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

D. Air Infiltration for Metal Roof Panels: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of roof area when tested according to ASTM E 1680 at negative test-pressure difference of 1.57 lbf/sq. ft.

E. Air Infiltration for Metal Wall Panels: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of wall area when tested according to ASTM E 283 at static-air-pressure difference of 6.24 lbf/sq. ft.

F. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E 1646 at test-pressure difference of 2.86 lbf/sq. ft.

G. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E 331 at a minimum differential pressure of 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft. and not more than 12 lbf/sq. ft.

H. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for Class 90.

1.6 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of the following metal building system components:

1. Structural-framing system.
2. Metal roof panels.
3. Fixed metal wall panels.
4. Removable metal wall panels.
5. Flashing, soffits and trim.
6. Doors.
7. Louvers.
8. Accessories.

B. Shop Drawings: For the following metal building system components. Include plans, elevations, sections, details, and attachments to other work.

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Anchor-Bolt Plans: Submit anchor-bolt plans before foundation work begins. Include location, diameter, and projection of anchor bolts required to attach metal building to foundation. Indicate column reactions at each location.
3. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.

   a. Show provisions for attaching service walkways, platforms and pipe racks.

4. Metal Roof and Wall Panel Layout Drawings: Show layouts of metal panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.

   a. Show roof-mounted items including equipment supports, pipe supports and penetrations, lighting fixtures, snow guards, and items mounted on roof curbs.

b. Show wall-mounted items including doors, removable areas of wall, louvers, and lighting fixtures.

5. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:

   a. Flashing and trim.
   b. Gutters.
   c. Downspouts.
   d. Louvers.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of sizes indicated below.

1. Metal Roof and Wall Panels: Nominal 12 inches long by actual panel width. Include fasteners, closures, and other exposed panel accessories.
2. Flashing and Trim: Nominal 12 inches long. Include fasteners and other exposed accessories.
3. Removable Wall Area Framing: Full-size, nominal 12-inch- long frame samples showing typical profile.
4. Accessories: Nominal 12-inch- long Samples for each type of accessory.

D. Product Certificates: For each type of metal building system, signed by product manufacturer.

1. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

   a. Name and location of Project.
   b. Order number.
   c. Name of manufacturer.
   d. Name of Contractor.
   e. Building dimensions including width, length, height, and roof slope.
   f. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
   g. Governing building code and year of edition.
   h. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category, and auxiliary loads (cranes).
   i. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
   j. Building-Use Category: Indicate category of building use and its effect on load importance factors.
   k. AISC Certification for Category MB: Include statement that metal building system and components were designed and produced in an AISC-Certified Facility by an AISC-Certified Manufacturer.

E. Welding certificates.

F. Erector Certificate: Signed by manufacturer certifying that erector complies with requirements.

G. Manufacturer Certificate: Signed by manufacturer certifying that products comply with requirements.

H. Qualification Data: For Erector professional engineer.

I. Material Test Reports: Signed by manufacturers certifying that the following products comply with requirements:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shop primers.
5. Nonshrink grout.

J. Source quality-control test reports.

K. Field quality-control test reports.

L. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for insulation and vapor retarders. Include reports for thermal resistance, fire-test-response characteristics, water-vapor transmission, and water absorption.

M. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor who performed surveys certify their accuracy.

N. Maintenance Data: For metal panel finishes and door hardware to include in maintenance manuals.

O. Warranties: Special warranties specified in this Section.

P. Other Action Submittals:

1. Door Schedule: For doors and frames. Include details of reinforcement.

   a. Door Hardware Schedule: Include details of fabrication and assembly of door hardware. Organize schedule into door hardware sets indicating complete designations of every item required for each door or opening.
   b. Keying Schedule: Detail Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.7 QUALITY ASSURANCE

A. Erector Qualifications: An experienced erector who has specialized in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

B. Manufacturer Qualifications: A qualified manufacturer and member of MBMA.

1. AISC Certification for Category MB: An AISC-Certified Manufacturer that designs and produces metal building systems and components in an AISC-Certified Facility.
2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

C. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing surveying services of the kind indicated.

D. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.

E. Source Limitations: Obtain primary metal building system components, including structural framing and metal panel assemblies, through one source from a single manufacturer.

F. Product Options: Drawings indicate size, profiles, and dimensional requirements of metal building system and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

G. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

H. Structural Steel: Comply with AISC's "Specification for Structural Steel Buildings--Allowable Stress Design, Plastic Design," or AISC's "Load and Resistance Factor Design Specification for Structural Steel Buildings," for design requirements and allowable stresses.

I. Cold-Formed Steel: Comply with AISI's "Specification for the Design of Cold-Formed Steel Structural Members," or AISI's "Load and Resistance Factor Design Specification for Steel Structural Members," for design requirements and allowable stresses.

J. Pre-Erection Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to metal building systems including, but not limited to, the following:

1. Inspect and discuss condition of foundations and other preparatory work performed by other trades.
2. Review structural load limitations.
3. Review and finalize construction schedule and verify availability of materials, Erector's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review required testing, inspecting, and certifying procedures.
5. Review weather and forecasted weather conditions and procedures for unfavorable conditions.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness and with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

1.9 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements:

1. Established Dimensions for Foundations: Comply with established dimensions on approved anchor-bolt plans, establishing foundation dimensions and proceeding with fabricating structural framing without field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.
2. Established Dimensions for Metal Panels: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal panels without field measurements, or allow for field trimming metal panels. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.10 COORDINATION

A. Coordinate size and location of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

B. Coordinate installation of equipment supports and roof and wall penetrations.

C. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

D. Frame around removable wall areas, and frame removable wall panels.

1.11 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam, metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: The design for metal building systems is based on Butler Mfg. Co., Architectural Systems. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:

1. American Steel Building Company, Inc.; Division of NCI Building Systems, LLP.
2. Butler Manufacturing Company.

3. Ceco Building Systems; Division of Robertson-Ceco Corporation.
4. Star Building Systems; Division of Robertson-Ceco Corporation.
5. United Structures of America, Inc.
6. VP Buildings, Inc.; a United Dominion Company.

2.2 STRUCTURAL-FRAMING MATERIALS

A. W-Shapes: ASTM A 992/A 992M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.

B. Channels, Angles, M-Shapes, and S-Shapes: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.

C. Plate and Bar: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.

D. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B or C, structural tubing.

F. Structural-Steel Sheet: Hot-rolled, ASTM A 1011/A 1011M, Structural Steel (SS), Grades 30 through 55, or High-Strength Low Alloy Steel (HSLAS), Grades 45 through 70; or cold-rolled, ASTM A 1008/A 1008M, Structural Steel (SS), Grades 25 through 80, or High-Strength Low Alloy Steel (HSLAS), Grades 45 through 70.

G. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80 or High-Strength Low Alloy Steel (HSLAS), Grades 50 through 80; with G60 coating designation; mill phosphatized.

H. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80 or High-Strength Low Alloy Steel (HSLAS), Grades 50 through 80; with G90 coating designation.

I. Joist Girders: Manufactured according to "Standard Specifications for Joist Girders," in SJI's "Standard Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders," with steel-angle, top- and bottom-chord members; with end- and top-chord arrangements as indicated and required for primary framing.

J. Steel Joists: Manufactured according to "Standard Specifications for Open Web Steel Joists, K-Series," in SJI's "Standard Specifications, Load Tables, and Weight Tables for Steel Joists and

Joist Girders," with steel-angle, top- and bottom-chord members; with end- and top-chord arrangements as indicated and required for secondary framing.

K. Non-High-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A, carbon-steel, hex-head bolts; ASTM A 563 carbon-steel hex nuts; and ASTM F 844 plain (flat) steel washers.

1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

L. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
2. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex-head steel structural bolts with splined ends.

   a. Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50

M. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers, plain.

N. Unheaded Anchor Rods: ASTM F 1554, Grade 36.

1. Configuration: Straight.
2. Nuts: ASTM A 563 hex carbon steel.
3. Plate Washers: ASTM A 36/A 36M carbon steel.
4. Washers: ASTM F 436 hardened carbon steel.
5. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

O. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.

1. Nuts: ASTM A 563 hex carbon steel.
2. Plate Washers: ASTM A 36/A 36M carbon steel.
3. Washers: ASTM F 436 hardened carbon steel.
4. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

P. Threaded Rods: ASTM F 1554, Grade 36.

1. Nuts: ASTM A 563 hex carbon steel.
2. Washers: ASTM A 36/A 36M carbon steel.
3. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C

Q. Primer: SSPC-Paint 15, Type I, red oxide.

2.3 MATERIALS FOR FIELD-ASSEMBLED METAL PANELS

A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80, with G90 coating designation.
2. Surface: Embossed finish.
3. Exposed Finishes: Apply the following coil coating, as specified or indicated on Drawings:

a. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions, except as modified below:

1) Humidity Resistance: 2000 hours.
2) Salt-Spray Resistance: 2000 hours.

2.4 DOOR AND FRAME MATERIALS

A. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with G60 zinc (galvanized) or A60 zinc-iron-alloy (galvannealed) coating designation.

2.5 MISCELLANEOUS MATERIALS

A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.

1. Fasteners for Metal Roof and Wall Panels: Self-drilling Type 410 stainless-steel or self-tapping Type 304 stainless-steel or zinc-alloy-steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal panels.
2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
3. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

C. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

D. Metal Panel Sealants:

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
2. Joint Sealant: ASTM C 920; one-part elastomeric polyurethane, polysulfide, or silicone-rubber sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.6 FABRICATION, GENERAL

A. General: Design components and field connections required for erection to permit easy assembly, and easy removal and reinstallation of framed R.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual": Chapter IV, Section 9, "Fabrication and Erection Tolerances."

C. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

2.7 STRUCTURAL FRAMING

A. General:

1. Primary Framing: Shop fabricate framing components to indicated size and section with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

    a. Make shop connections by welding or by using high-strength bolts.
    b. Join flanges to webs of built-up members by a continuous submerged arc-welding process.
    c. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
    d. Weld clips to frames for attaching secondary framing members.
    e. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary structural members with specified primer after fabrication.

2. Secondary Framing: Shop fabricate framing components to indicated size and section by roll-forming or break-forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

    a. Make shop connections by welding or by using non-high-strength bolts.
    b. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary structural members with specified primer after fabrication.

B. Primary Framing: Manufacturer's standard structural primary framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafter, rake, and canopy beams; sidewall, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

    a. Slight variations in span and spacing may be acceptable if necessary to meet manufacturer's standard, as approved by Architect.

2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
3. Frame Configuration: One-directional sloped.
4. Exterior Column Type: Uniform depth.
5. Rafter Type: Uniform depth.

C. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:

1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet; with minimum thickness of 0.0598 inch.
2. End-Wall Rafters: C-shaped, cold-formed, structural-steel sheet; with minimum thickness of 0.0598 inch; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.

D. Secondary Framing: Manufacturer's standard secondary framing members, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Fabricate framing from cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet prepainted with coil coating, unless otherwise indicated, to comply with the following:

1. Purlins: C- or Z-shaped sections; fabricated from minimum 0.0598-inch- thick steel sheet, built-up steel plates, or structural-steel shapes; minimum 2-1/2-inch- wide flanges.

   a. Depth: As required to comply with system performance requirements.

2. Girts: C- or Z-shaped sections; fabricated from minimum 0.0598-inch- thick steel sheet, built-up steel plates, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees to flange and with minimum 2-1/2-inch- wide flanges.

   a. Depth: As required to comply with system performance requirements.

3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from 0.0598-inch- thick steel sheet, built-up steel plates, or structural-steel shapes; to provide adequate backup for metal panels.
4. Flange Bracing: Minimum 2-by-2-by-1/8-inch structural-steel angles or 1-inch diameter, cold-formed structural tubing to stiffen primary frame flanges.
5. Sag Bracing: Minimum 1-by-1-by-1/8-inch structural-steel angles.
6. Base or Sill Angles: Minimum 3-by-2-by-0.0598-inch zinc-coated (galvanized) steel sheet.
7. Purlin and Girt Clips: Minimum 0.0598-inch- thick, steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
8. Secondary End-Wall Framing: Manufacturer's standard sections fabricated from minimum 0.0598-inch- thick, zinc-coated galvanized steel sheet.
9. Framing for Openings: Channel shapes; fabricated from minimum 0.0598-inch- thick, cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings, and head, jamb, and sill of other openings.
10. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

E. Bracing: Provide adjustable wind bracing as follows:

1. Rods: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50; or ASTM A 529/A 529M, Grade 50; minimum 1/2-inch- diameter steel; threaded full length or threaded a minimum of 6 inches at each end.
2. Cable: ASTM A 475, 1/4-inch- diameter, extra-high-strength grade, Class B zinc-coated, 7-strand steel; with threaded end anchors.
3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
4. Rigid Portal Frames: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
5. Fixed-Base Columns: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
6. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.
7. Bracing: Provide wind bracing using any method specified above, at manufacturer's option.

F. Bolts: Provide plain finish bolts for structural-framing components that are primed or finish painted. Provide zinc-plated or hot-dipped galvanized bolts for structural-framing components that are galvanized.

G. Factory-Primed Finish: Apply specified primer immediately after cleaning and pretreating.

1. Prime primary, secondary, and end-wall structural-framing members to a minimum dry film thickness of 1 mil.

   a. Prime secondary steel framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil on each side.

2. Prime galvanized members with specified primer, after phosphoric acid pretreatment.

2.8 METAL ROOF PANELS

A. Trapezoidal-Rib, Standing-Seam Metal Roof Panels: Formed with raised trapezoidal ribs at panel edges and flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Aluminum-zinc alloy-coated steel sheet, 0.0269 inch thick.

   a. Exterior Finish: Fluoropolymer.
   b. Color: Manufacturer’s standard white.

2. Clips: Manufacturer's standard, floating type to accommodate thermal movement; fabricated from zinc-coated galvanized steel, aluminum-zinc alloy-coated steel, or stainless-steel sheet.
3. Joint Type: Panels snapped together or mechanically seamed, folded as standard with manufacturer.
4. Panel Coverage: 24 inches.
5. Panel Height: 3 inches.
6. Uplift Rating: UL 90.

2.9 MATERIALS FOR FIELD-ASSEMBLED METAL PANELS

A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80, with G90 coating designation.
2. Surface: Embossed finish.
3. Exposed Finishes: Apply the following coil coating, as specified or indicated on Drawings:
   a. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions, except as modified below:

      1) Humidity Resistance: 2000 hours.
      2) Salt-Spray Resistance: 2000 hours.

2.10 FIELD-ASSEMBLED METAL WALL PANELS

A. Tapered-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced between major ribs; designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) steel sheet, 0.0269 inch thick.

   a. Exterior Finish: Fluoropolymer.
   b. Color: Manufacturer’s standard gray, as selected.

2. Major-Rib Spacing: 12 inches o.c.
3. Panel Coverage: 36 inches.
4. Panel Height: 1.5 inches.

2.11 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

B. Metal Soffit Panels: Match profile and material of metal roof panels.

1. Finish: Match finish and color of metal roof panels.

C. Tapered-Rib-Profile, Exposed-Fastener Metal Soffit Panels: Formed with raised, trapezoidal major ribs and flat pan between major ribs; designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Aluminum-zinc alloy-coated steel sheet, 0.0209 inch thick.

a. Exterior Finish: Fluoropolymer.
b. Color: Manufacturer's standard white.

2. Major-Rib Spacing 12 inches.
3. Panel Coverage: 36 inches.
4. Panel Height: 1.25 inches.

2.12 DOORS AND FRAMES

A. Swinging Personnel Doors and Frames: Metal building system manufacturer's standard half-glazed doors and frames; prepared and reinforced at strike and hinges to receive factory- and field-applied hardware according to ANSI/DHI A115 Series.

1. Steel Doors: 1-3/4 inches thick; fabricated from 0.0329-inch- uncoated thickness, metallic-coated steel face sheets; of styles indicated; hemmed at both vertical edges; with 0.0528-inch- uncoated thickness, inverted metallic-coated steel channels welded to face sheets at top and bottom of door.
a. Core: Kraft honeycomb with U-factor rating of at least 0.47 Btu/sq. ft. x h x deg F.

b. Glazed Vision Lights: Provide manufacturer's standard half-glazed doors with tempered float glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Quality-Q3, Class 1 (clear), 6 mm thick.

2. Steel Frames: Fabricate 2-inch- wide face frames from 0.0528-inch- uncoated thickness, metallic-coated steel sheet.

   a. Type: Factory welded.

3. Fabricate concealed stiffeners, reinforcement, edge channels, and moldings from either cold- or hot-rolled steel sheet.
4. Hardware: Comply with ANSI/DHI A115 Series and as follows:

   a. Provide hardware for each door leaf, as follows:

      1) Hinges: Three plain -bearing, standard weight, full-mortise, stainless-steel, template-type hinges; 4-1/2 by 4-1/2 inches, with nonremovable pin.
      2) Lockset: Key-in-lever cylindrical type.
      3) Threshold: Extruded aluminum.
      4) Silencers: Pneumatic rubber; three silencers on strike jambs of single door frames and two silencers on heads of double door frames.
      5) Closer: Surface-applied, standard-duty hydraulic type.
      6) Weather Stripping: Vinyl applied to head and jambs, with vinyl sweep at sill.

5. Anchors and Accessories: Manufacturer's standard units, galvanized according to ASTM A 123/A 123M.
6. Fabrication: Fabricate doors and frames to be rigid; neat in appearance; and free from defects, warp, or buckle. Provide continuous welds on exposed joints; grind, dress, and make welds smooth, flush, and invisible.
7. Finishes for Personnel Doors and Frames:

   a. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

      1) Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

   b. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply the primer specified below immediately after cleaning and pretreating.

1) Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI A250.10 acceptance criteria.

c. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard 2-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat.

B. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

C. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels, unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
2. Clips: Manufacturer's standard, formed from stainless-steel sheet, designed to withstand negative-load requirements.
3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from stainless-steel sheet or nylon-coated aluminum sheet.
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

D. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels, unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or

premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

E. Flashing and Trim: Formed from minimum 0.0159-inch- thick, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
2. Opening Trim: Minimum 0.0269-inch- thick, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

F. Gutters: Formed from minimum 0.0159-inch- thick, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

1. Gutter Supports: Fabricated from same material and finish as gutters; spaced 36 inches o.c.
2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

G. Downspouts: Formed from 0.0159-inch- thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters; spaced 10 feet o.c.

H. Louvers: Size and design indicated; self-framing and self-flashing. Fabricate welded frames from minimum 0.0428-inch- thick, metallic-coated steel sheet; finished to match metal wall panels. Form blades from 0.0329-inch- thick, metallic-coated steel sheet; folded or beaded at edges, set at an angle that excludes driving rains, and secured to frames by riveting or welding. Fabricate louvers with equal blade spacing to produce uniform appearance.

1. Blades: Fixed, with storm-proof profile.
2. Free Area: Not less than 7.0 sq. ft. for 48-inch- wide by 48-inch- high louver.
3. Bird Screening: Galvanized steel, 1/2-inch- square mesh, 0.041-inch wire; with rewirable frames, removable and secured with clips, fabricated of same kind and form of metal and with same finish as for louvers.

   a. Mounting: Interior face of louvers.

4. Vertical Mullions: Provide mullions at spacings recommended by manufacturer, or 72 inches o.c., whichever is less.

I. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

2.13 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Tests and Inspections:

1. Bolted Connections: Shop-bolted connections shall be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
2. Welded Connections: In addition to visual inspection, shop-welded connections shall be tested and inspected according to AWS D1.1 and the following inspection procedures, at inspector's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

D. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. For the record, prepare written report, endorsed by Erector, listing conditions detrimental to performance of work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with Erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place, unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system according to manufacturer's written erection instructions and erection drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base, Leveling and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing true to line, level, plumb, rigid, and secure. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

   a. Joint Type: Snug tightened or pretensioned.

G. Secondary Framing: Erect framing true to line, level, plumb, rigid, and secure. Fasten secondary framing to primary framing using clips with field connections using non-high-strength bolts.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and removable wall panels.
3. Provide supplemental framing at entire perimeter of openings, including doors, louvers, and other penetrations of roof and walls.

H. Steel Joists and Joist Girders: Install joists, girders, and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Standard Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders," joist manufacturer's written recommendations, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Bolt joists to supporting steel framework using high-strength structural bolts, unless otherwise indicated. Comply with RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
5. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.4 METAL PANEL INSTALLATION, GENERAL

A. Examination: Examine primary and secondary framing to verify that structural panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before metal panel installation.

B. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

   a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports, unless otherwise indicated.
3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over, but not attached to, structural supports with end laps in alignment. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

C. Lap-Seam Metal Panels: Install screw fasteners with power tools having controlled torque adjusted to compress neoprene washer tightly without damage to washer, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

D. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

E. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal panel manufacturer.

3.5 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge, unless otherwise indicated or restricted by shipping limitations.

1. Install ridge caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Field-Assembled, Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
5. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Predrill panels for fasteners.
6. Provide metal closures at peaks, rake edges and rake walls.

C. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

D. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels on exterior side of, and perpendicular to, girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement. Attach metal wall panels to supports with exposed fasteners as recommended by manufacturer.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
2. Shim or otherwise plumb substrates receiving metal wall panels.
3. When two rows of metal panels are required, lap panels 4 inches minimum.
4. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction. Predrill panels.
5. Flash and seal metal wall panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
6. Install screw fasteners in predrilled holes.
7. Install flashing and trim as metal wall panel work proceeds.
8. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated, or if not indicated, as necessary for waterproofing.
9. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws.
10. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

B. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 feet, nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.7 METAL SOFFIT PANEL INSTALLATION

A. Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.

B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.8 DOOR AND FRAME INSTALLATION

A. General: Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for metal wall panels.

B. Personnel Doors and Frames: Install doors and frames according to ANSI A250.8. Shim as necessary to comply with DHI A115.IG. Fit non-fire-rated doors accurately in their respective frames, with the following clearances:

1. Between Doors and Frames at Jambs and Head: 1/8 inch.
2. Between Edges of Pairs of Doors: 1/8 inch.
3. At Door Sills with Threshold: 3/8 inch.

C. Door Hardware: Mount units at heights indicated in DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

1. Install surface-mounted items after finishes have been completed on substrates involved.
2. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
3. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
4. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in Division 7 Section "Joint Sealants."

3.9 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Install components for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
3. Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners

where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 feet o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.

E. Louvers: Locate and place louver units level, plumb, and at indicated alignment with adjacent work.

1. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
2. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.
3. Protect galvanized- and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
4. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

F. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. High-Strength, Field-Bolted Connections: Connections shall be tested and inspected during installation according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
2. Welded Connections: In addition to visual inspection, field-welded connections shall be tested and inspected according to AWS D1.1 and the following inspection procedures, at inspector's option:

    a. Liquid Penetrant Inspection: ASTM E 165.
    b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    c. Ultrasonic Inspection: ASTM E 164.
    d. Radiographic Inspection: ASTM E 94.

B. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.

3.11 ADJUSTING

A. Doors: After completing installation, test and adjust doors to operate easily, free of warp, twist, or distortion.

B. Door Hardware: Adjust and check each operating item of door hardware and each door to ensure proper operation and function of every unit. Replace units that cannot be adjusted to operate as intended.

1. Door Closers: Adjust door closers to compensate for final operation of heating and ventilating equipment. Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

3.12 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Touchup Painting: After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.

1. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or SSPC-SP 3, "Power Tool Cleaning."
2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

D. Touchup Painting: Cleaning and touchup painting are specified in Division 9 painting Sections.

E. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

F. Doors and Frames: Immediately after installation, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

1. Immediately before final inspection, remove protective wrappings from doors and frames.
2. Clean metal surfaces immediately after installing doors. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances. Clean factory-glazed glass immediately after installation.

G. Louvers: Clean exposed surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

1. Restore louvers damaged during installation and construction period so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

a. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

3.13 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable accessories. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 13125

SECTION 13281N - ENGINEERING CONTROL OF ASBESTOS CONTAINING FLOORING MATERIALS

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PART 1 - GENERAL

A. REFERENCES

1. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z9.2(1979; R 1991) Fundamentals Governing the Design and Operation of Local Exhaust Systems

ANSI Z88.2(1992) Respiratory Protection

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 732(1995) Aging Effects of Artificial Weathering on Latex Sealants

ASTM D 522(1993; Rev. A) Mandrel Bend Test of Attached Organic Coatings

ASTM D 1331(1989; R 1995) Surface and Interfacial Tension of Solutions of Surface-Active Agents

ASTM D 2794(1993) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)

ASTM E 84(1998) Surface Burning Characteristics of Building Materials

ASTM E 96(1995) Water Vapor Transmission of Materials

ASTM E 119(1998) Fire Tests of Building Construction and Materials

ASTM E 736(1992) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members

ASTM E 1368(1997) Visual Inspection of Asbestos Abatement Projects

ASTM E 1494(1992; R 1996) Encapsulants for Spray- or Trowel-Applied Friable Asbestos-Containing Building Materials

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.103 Respiratory Protection

29 CFR 1926.51 Sanitation

29 CFR 1926.200 Accident Prevention Signs and Tags

29 CFR 1926.59 Hazard Communication

29 CFR 1926.1101 Asbestos, Tremolite, Anthophyllite, Actinolite

40 CFR 61-SUBPART A General Provisions

40 CFR 61-SUBPART M National Emission Standard for Asbestos

40 CFR 763 Asbestos Containing Material in Schools

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 560/5-85-024 Guidance for Controlling Asbestos Containing Materials in Buildings

UNDERWRITERS LABORATORIES (UL)

UL 586(1996) High-Efficiency, Particulate, Air Filter Units

STATE OF OHIO DIVISION OF HEALTH

Title 64 Series 63 Asbestos Abatement Licensing Rule

B. DEFINITIONS

1. ACM - Asbestos Containing Materials.

2. Amended Water - Water containing a wetting agent or surfactant with a maximum surface tension of 29 dynes per centimeter when tested in accordance with ASTM D 1331.

3. Area Sampling - Sampling of asbestos fiber concentrations which approximates the concentrations of asbestos in the theoretical breathing zone but is not actually collected in the breathing zone of an employee.

4. Asbestos - The term asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, and actinolite asbestos and any of these minerals that has been chemically treated or altered. Materials are considered to contain asbestos if the asbestos content of the material is determined to be at least one percent.

5. Asbestos Control Area - That area where asbestos removal operations are performed which is isolated by physical boundaries which assist in the prevention of the uncontrolled release of asbestos dust, fibers, or debris.

6. Asbestos Fibers - Those fibers having an aspect ratio of at least 3:1 and longer than 5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 7400.

7. Asbestos Permissible Exposure Limit - 0.1 fibers per cubic centimeter of air as an 8-hour time weighted average measured in the breathing zone as defined by 29 CFR 1926.1101 or other Federal legislation having legal jurisdiction for the protection of workers health.

8. Background - The ambient airborne asbestos concentration in an uncontaminated area as measured prior to any asbestos hazard abatement efforts. Background concentrations for other (contaminated) areas are measured in similar but asbestos free locations.

9. Contractor - The Contractor is that individual, or entity under contract to the Owner to perform the herein listed work.

10. Encapsulation - The abatement of an asbestos hazard through the appropriate use of chemical encapsulants.

11. Encapsulants - Specific materials in various forms used to chemically or physically entrap asbestos fibers in various configurations to prevent these fibers from becoming airborne. There are four types of encapsulants as follows which must comply with performance requirements as specified herein.

    a. Removal Encapsulant (can be used as a wetting agent)
    b. Bridging Encapsulant (used to provide a tough, durable surface coating to asbestos containing material)
    c. Penetrating Encapsulant (used to penetrate the asbestos containing material encapsulating all asbestos fibers and preventing fiber release due to routine mechanical damage)
    d. Lock-Down Encapsulant (used to seal off or "lock-down" minute asbestos fibers left on surfaces from which asbestos containing material has been removed).

12. Friable Asbestos Material - One percent asbestos containing material that can be crumbled, pulverized, or reduced to powder by hand pressure when dry.

13. Glovebag Technique - Those asbestos removal and control techniques put forth in 29 CFR 1926.1101.

14. HEPA Filter Equipment - High efficiency particulate air (HEPA) filtered vacuum and/or exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters shall retain 99.97 percent of particles 0.3 microns or larger as indicated in UL 586.

15. Negative Pressure Enclosure (NPE) - That engineering control technique described as a negative pressure enclosure in 29 CFR 1926.1101.

16. Non-friable Asbestos Material - Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, removal, or mishap.

17. Personal Sampling - Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed in accordance with 29 CFR 1926.1101.

18. Private Qualified Person (PQP) - That qualified person hired by the Contractor to perform the herein listed tasks.

19. Qualified Person (QP) - A Registered Architect, Professional Engineer, Certified Industrial Hygienist, consultant or other qualified person who has successfully completed training and is therefore accredited under a legitimate State Model Accrediation Plan as described in 40 CFR 763 as a Building Inspector, Contractor/Supervisor Abatement Worker, and Asbestos Project Designer; and has successfully completed the National Institute of Occupational Safety and Health (NIOSH) 582 course "Sampling and Evaluating Airborne Asbestos Dust" or equivalent. The QP must be qualified to perform visual inspections as indicated in ASTM E 1368. The QP shall be appropriately licensed in the State of Ohio.

20. TEM - Refers to Transmission Electron Microscopy.

21. Time Weighted Average (TWA) - The TWA is an 8-hour time weighted average airborne concentration of asbestos fibers.

22. Wetting Agent - A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most 29 dynes per centimeter when tested in accordance with ASTM D 1331.

C. REQUIREMENTS

1. Description of Work

a. The work covered by this section includes the handling and control of asbestos containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any asbestos containing materials generated by the work. More specific operational procedures shall be outlined in the Asbestos Hazard Abatement Plan called for elsewhere in this specification. The asbestos work includes the removal of the following non-friable asbestos-containing materials located within the EPA AWBERC Cooling Towers in Cincinnati, Ohio as described in the survey report entitled Report of Limited Asbestos-Containing Material Survey, dated July 15, 2004 and prepared by MACTEC Engineering and Consulting:

1) Cementitious wall panels, north and south ends of cooling towers, approx. 1,500 square feet (SF); and
2) Cementitious cooling fins, east and west sides of cooling towers, approx. 5,000 SF.

2. Under normal conditions, non-friable or chemically bound materials containing asbestos would not be considered hazardous; however, this material may release airborne asbestos fibers during removal and therefore must be handled in accordance with the removal and disposal procedures as specified herein. Provide negative pressure enclosure techniques as outlined in this specification.

3. Medical Requirements

a. Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in 29 CFR 1926.1101.

4. Medical Examinations

a. Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1926.1101 or other pertinent State or local directives. This requirement must have been satisfied within the 12 months prior to the start of work on this contract. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word "ASBESTOS."

5. Medical Records

a. Maintain complete and accurate records of employees' medical examinations, medical records, and exposure data for a period of 50 years after termination of employment and make records of the required medical examinations and exposure data available for inspection and copying to: The Assistant Secretary of Labor for Occupational Safety and Health (OSHA), or authorized representatives of them, and an employee's physician upon the request of the employee or former employee.

6. Employee Training

a. Submit certificates, prior to the start of work but after the main abatement submittal, signed by each employee indicating that the employee has received training in the proper handling of materials and wastes that contain asbestos in accordance with 40 CFR 763; understands the health implications and risks involved, including the illnesses possible from exposure to airborne asbestos fibers; understands the use and limits of the respiratory equipment to be used; and understands the results of monitoring of airborne quantities of asbestos as related to health and respiratory equipment as indicated in 29 CFR 1926.1101 on an initial and annual basis. Certificates shall be organized by individual worker, not grouped by type of certification. Post appropriate evidence of compliance with the training requirements of 40 CFR 763. Train all personnel involved in the asbestos control work in accordance with United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or State training criteria whichever is more stringent. The Contractor shall document the training by providing: dates of training, training entity, course outline, names of instructors, and qualifications of instructors upon request by the Contracting Officer. Furnish each employee with respirator training and fit testing administered by the PQP as required by 29 CFR 1926.1101. Fully cover engineering and other hazard control techniques and procedures.

7. Permits, Licenses, and Notifications

a. Obtain necessary permits and licenses in conjunction with asbestos removal, encapsulation, hauling, and disposition, and furnish notification of such actions required by Federal, State, regional, and local authorities prior to the start of work. Notify the Regional Office of the United States Environmental Protection Agency (USEPA), State of Ohio environmental protection agency, and the Contracting Officer in writing 10 working days prior to commencement of work in accordance with 40 CFR 61-SUBPART M and 16 VAC 25-20-30. Notify the Contracting Officer and other appropriate Government agencies in writing 10 working days prior to the start of asbestos work as indicated in applicable laws, ordinances, criteria, rules, and regulations. Submit copies of all Notifications to the Contracting Officer.

8. Environment, Safety and Health Compliance

a. In addition to detailed requirements of this specification, comply with those applicable laws, ordinances, criteria, rules, and regulations of Federal, State, regional, and local authorities regarding handling, storing, transporting, and disposing of asbestos waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.1101, 40 CFR 61-SUBPART A, 40 CFR 61-SUBPART M, and Ohio asbestos regulations. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification, applicable laws, rules, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirement as defined by the Government shall apply. The following

laws, ordinances, criteria, rules and regulations regarding removal, handling, storing, transporting and disposing of asbestos materials apply along with applicable State of Ohio and local regulations:

1) Occupational Safety and Health Administration (OSHA), U.S. Department of Labor
   a) 29 CFR 1910 (General Industry) and 29 CFR 1926 (Construction) Occupational Safety and Health Standards
   b) 29 CFR 1910.1001 and 29 CFR 1926.1101 Asbestos
   c) 29 CFR 1910.134 Respiratory Protection
   d) 29 CFR 1910.1200 Hazard Communication
2) U. S. Department of Transportation
   a) 49 CFR 171 Subchapter C, Hazardous Materials Regulations
   b) 49 CFR 172 Subchapter C, Shipping Container Specifications
3) U.S. Environmental Protection Agency
   a) 40 CFR 763, Toxic Substances Control Act; particularly Subpart E, Asbestos Containing Materials in Schools
   b) 40 CFR 61, Sub-parts A and M, National Emission Standard for Hazardous Air Pollutants (NESHAP)

9. Respiratory Protection Program

   a. Establish and implement a respirator program as required by ANSI Z88.2, 29 CFR 1926.1101, and 29 CFR 1926.103. Submit a written description of the program to the Contracting Officer. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.

10. Respirator Program Records

   a. Submit records of the respirator program as required by ANSI Z88.2, 29 CFR 1926.103, and 29 CFR 1926.1101.

11. Asbestos Hazard Control Supervisor

   a. The Contractor shall be represented on site by a supervisor, trained using the model Contractor accreditation plan as indicated in the Federal statutes for all portions of the herein listed work.

12. Hazard Communication

   a. Adhere to all parts of 29 CFR 1926.59 and provide the Contracting Officer with a copy of the Material Safety Data Sheets (MSDS) for all materials brought to the site.

13. Asbestos Hazard Abatement Plan

   a. Submit a detailed plan of the safety precautions such as lockout, tagout, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan, not to be combined with other hazard abatement plans, shall be prepared, signed, and sealed by the PQP. Provide a Table of Contents for each abatement submittal, which shall follow the sequence of requirements in the contract. Such plan shall include but not be limited to the precise personal protective equipment to be used including, but not limited to, respiratory protection, type of whole-body protection, the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method, interface of

trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos sealer to be used, locations of local exhaust equipment, planned air monitoring strategies, and a detailed description of the method to be employed in order to control environmental pollution. The plan shall also include (both fire and medical emergency) response plans. The Asbestos Hazard Abatement Plan must be approved in writing prior to starting any asbestos work. The Contractor, Asbestos Hazard Control Supervisor, and PQP shall meet with the Contracting Officer prior to beginning work, to discuss in detail the Asbestos Hazard Abatement Plan, including work procedures and safety precautions. Once approved by the Contracting Officer, the plan will be enforced as if an addition to the specification. Any changes required in the specification as a result of the plan shall be identified specifically in the plan to allow for free discussion and approval by the Contracting Officer prior to starting work.

14. Testing Laboratory

a. Submit the name, address, and telephone number of each testing laboratory selected for the analysis, and reporting of airborne concentrations of asbestos fibers along with evidence that each laboratory selected holds the appropriate State of Ohio license and/or permits and certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) and/or successful participation of the laboratory in the Proficiency Analytical Testing (PAT) Program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos analysis.

15. Landfill Approval

a. Submit written evidence that the landfill for disposal is approved for asbestos disposal by the USEPA, State of Ohio and local regulatory agency(s). Submit to the Contracting Officer, waste shipment records, prepared in accordance with Federal regulations, signed and dated by an agent of the landfill, certifying the amount of asbestos materials delivered to the landfill, within 3 days after delivery. In those States that require a hazardous waste manifest the Contractor shall submit, within 3 days, signed copies of such to the Contracting Officer.

16. Medical Certification

a. Provide a written certification for each worker and supervisor, signed by a licensed physician indicating that the worker and supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1926.103 as prescribed by law. Submit certificates prior to the start of work but after the main abatement submittal.

D. SUBMITTALS

1. SD-03 Product Data

a. Local exhaust equipment;
b. Vacuums;
c. Respirators;
d. Pressure differential automatic recording instrument;
e. Amended water;

f. Material Safety Data Sheets (MSDS) for all materials proposed for transport to the project site;
g. Encapsulants;

2. SD-06 Test Reports

a. Air sampling results;
b. Pressure differential recordings for local exhaust system;
c. Asbestos disposal quantity report;
d. Clearance sampling;

3. SD-07 Certificates

a. Asbestos hazard abatement plan;
b. Testing laboratory;
c. Private qualified person documentation;
d. Landfill approval;
e. Employee training;
f. Medical certification requirements;
g. Waste shipment records and if applicable exemption report;
h. Respiratory Protection Program;
i. Hazardous waste manifest;
j. Vacuums;
k. Water filtration equipment;
l. Ventilation systems;
m. Other equipment used to contain airborne asbestos fibers;
n. Chemical encapsulants sealers;
o. Notifications
p. Show compliance with ANSI Z9.2 by providing manufacturers' certifications.

4. SD-11 Closeout Submittals

a. Notifications;
b. Rental equipment;
c. Respirator program records;
d. Permits and licenses;

E. QUALITY ASSURANCE

1. Private Qualified Person Documentation

a. Submit the name, address, and telephone number of the Private Qualified Person (PQP) selected to prepare the Asbestos Hazard Abatement Plan, direct monitoring and training, and documented evidence that the PQP has successfully completed training in and is accredited and where required is certified as, a Building Inspector, Contractor/Supervisor Abatement Worker, and Asbestos Project Designer as described by 40 CFR 763 and has successfully completed the National Institute of Occupational Safety and Health (NIOSH) 582 course "Sampling and Evaluating Airborne Asbestos Dust" or equivalent. The PQP shall be appropriately licensed in the State of Ohio.

2. Air Sampling Results

a. Complete fiber counting and provide results to the PQP for review within 16 hours of the "time off" of the sample pump. Notify the Contracting Officer immediately of any airborne levels of asbestos fibers in excess of the acceptable

limits. Submit sampling results to the Contracting Officer and the affected Contractor employees where required by law within 3 working days, signed by the testing laboratory employee performing air sampling, the employee that analyzed the sample, and the PQP. Notify the Contractor and the Contracting Officer immediately of any variance in the pressure differential which could cause adjacent unsealed areas to have asbestos fiber concentrations in excess of 0.01 fibers per cubic centimeter or background whichever is higher. In no circumstance shall levels exceed 0.1 fibers per cubic centimeter.

3. Pressure Differential Recordings for Local Exhaust System

a. Provide a local exhaust system that creates a negative pressure of at least 0.02 inches of water relative to the pressure external to the enclosure and operate it continuously, 24 hours a day, until the temporary enclosure of the asbestos control area is removed. Submit pressure differential recordings for each work day to the PQP for review and to the Contracting Officer within 24 hours from the end of each work day.

F. EQUIPMENT

1. Rental Equipment

a. Provide a copy of the written notification to the rental company, if applicable, concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.

PART 2 - PRODUCTS

A. ENCAPSULANTS

1. Shall conform to current USEPA requirements, shall contain no toxic or hazardous substances as defined in 29 CFR 1926.59, and shall conform to the following performance requirements.

a. Removal Encapsulants

Requirement	Test Standard
Flame Spread - 25, Smoke Emission – 50	ASTM E 84
Life Expectancy - 20 years	ASTM C 732 Accelerated Aging Test
Permeability - Minimum 0.4 perms	ASTM E 96

b. Bridging Encapsulants

Requirement	Test Standard
Flame Spread - 25, Smoke Emission – 50	ASTM E 84
Life Expectancy - 20 years	ASTM C 732 Accelerated Aging Test
Permeability - Minimum 0.4 perms	ASTM E 96
Fire Resistance - Negligible affect on fire resistance rating over 3 hour test (Classified by UL for use over fibrous	ASTM E 119

and cementitious sprayed fireproofing)

Impact Resistance – Minimum 43 in/lb	ASTM D 2794 Gardner Impact Test
Flexibility - no rupture or cracking	ASTM D 522 Mandrel Bend Test

c. Penetrating Encapsulants

Requirement	Test Standard
Flame Spread - 25, Smoke Emission – 50	ASTM E 84
Life Expectancy - 20 years	ASTM C 732 Accelerated Aging Test
Permeability - Minimum 0.4 perms	ASTM E 96
Cohesion/Adhesion Test - 50 pounds of force/foot	ASTM E 736
Fire Resistance - Negligible affect on fire resistance rating over 3 hour test (Classified by UL for use over fibrous and cementitious sprayed fireproofing)	ASTM E 119
Impact Resistance – Minimum 43 in/lb	ASTM D 2794 Gardner Impact Test
Flexibility - no rupture or cracking	ASTM D 522 Mandrel Bend Test

d. Lock-down Encapsulants

Requirement	Test Standard
Flame Spread - 25, Smoke Emission – 50	ASTM E 84
Life Expectancy - 20 years	ASTM C 732 Accelerated Aging Test
Permeability - Minimum 0.4 perms	ASTM E 96
Fire Resistance - Negligible affect on fire resistance rating over 3 hour test (Classified by UL for use over fibrous and cementitious sprayed fireproofing)	ASTM E 119
Bond Strength: 100 pounds of force/foot (Tests compatibility with cementitious and fibrous fireproofing)	ASTM E 736

PART 3 - EXECUTION

A. EQUIPMENT

1. At all times, provide the Contracting Officer or the Contracting Officer's Representative, with at least two complete sets of personal protective equipment as required for entry to and inspection of the asbestos control area. Provide equivalent training to the Contracting Officer or a designated representative as provided to Contractor employees

in the use of the required personal protective equipment. Provide manufacturer's certificate of compliance for all equipment used to contain airborne asbestos fibers.

2. Respirators

   a. Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services.

   b. Respirators for Handling Asbestos

      1) Provide personnel engaged in pre-cleaning, cleanup, handling, and removal of asbestos materials with respiratory protection as indicated in 29 CFR 1926.1101 and 29 CFR 1926.103.

3. Exterior Whole Body Protection

   a. Outer Protective Clothing

      1) Provide personnel exposed to asbestos with disposable "non-breathable," whole body outer protective clothing, head coverings, gloves, and foot coverings. Provide disposable plastic or rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but shall not be used alone. Make sleeves secure at the wrists, make foot coverings secure at the ankles, and make clothing secure at the neck by the use of tape.

   b. Work Clothing

      1) Provide cloth work clothes for wear under the outer protective clothing and foot coverings and either dispose of or properly decontaminate them as recommended by the PQP after each use.

4. Personal Decontamination Unit

   a. Provide a temporary, negative pressure unit with a separate decontamination locker room and clean locker room with a shower that complies with 29 CFR 1926.51(f)(4)(ii) through (V) in between for personnel required to wear whole body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Keep street clothing and street shoes in the clean locker. HEPA vacuum and remove asbestos contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal. Do not wear work clothing between home and work. Locate showers between the decontamination locker room and the clean locker room and require that all employees shower before changing into street clothes. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Dispose of filters and residue as asbestos waste. Discharge clean water to the sanitary system. Dispose of asbestos contaminated work clothing as asbestos contaminated waste. Decontamination units shall be physically attached to the asbestos control area. Build both a personnel decontamination unit and an equipment decontamination unit onto and integral with each asbestos control area.

5. Eye Protection

   a. Provide goggles to personnel engaged in asbestos abatement operations when the use of a full face respirator is not required.

6. Warning Signs and Labels

a. Provide warning signs printed in English at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos.

b. Warning Sign

1) Provide vertical format conforming to 29 CFR 1926.200, and 29 CFR 1926.1101 minimum 20 by 14 inches displaying the following legend in the lower panel:

Legend	Notation
Danger	one inch Sans Serif Gothic or Block
Asbestos	one inch Sans Serif Gothic or Block
Cancer and Lung Disease Hazard	¼ inch Sans Serif Gothic or Block
Authorized Personnel Only	¼ inch Gothic
Respirators and Protective Clothing are Required in this Area	¼ inch Gothic

Spacing between lines shall be at least equal to the height of the upper of any two lines.

c. Warning Labels

1) Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be clearly legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD
BREATHING ASBESTOS DUST MAY
CAUSE SERIOUS BODILY HARM

7. Local Exhaust System

a. Provide a local exhaust system in the asbestos control area in accordance with ANSI Z9.2 and 29 CFR 1926.1101 that will provide at least four air changes per hour inside of the negative pressure enclosure. Local exhaust equipment shall be operated 24 hours per day, until the asbestos control area is removed and shall be leak proof to the filter and equipped with HEPA filters. Maintain a minimum pressure differential in the control area of minus 0.02 inch of water column relative to adjacent, unsealed areas. Provide continuous 24-hour per day

monitoring of the pressure differential with a pressure differential automatic recording instrument. In no case shall the building ventilation system be used as the local exhaust system for the asbestos control area. Filters on exhaust equipment shall conform to ANSI Z9.2 and UL 586. The local exhaust system shall terminate out of doors and remote from any public access or ventilation system intakes.

8. Tools

a. Vacuums shall be leak proof to the filter and equipped with HEPA filters. Filters on vacuums shall conform to ANSI Z9.2 and UL 586. Do not use power tools to remove asbestos containing materials unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation systems. Remove all residual asbestos from reusable tools prior to storage or reuse.

9. Rental Equipment

a. If rental equipment is to be used, furnish written notification to the rental agency concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.

B. WORK PROCEDURE

1. Removal of asbestos-containing cementitious wall panels or cooling fins shall be performed in accordance with the procedure outlined below.

a. Block and seal all openings to the building located near or inside the work area with six-mil thick plastic and waterproof duct tape.
b. Establish a regulated asbestos control work area with OSHA approved asbestos warning tape.
c. Place a 0.15 mm polyethylene drop cloth in the immediate work area of the manual demolition activities.
d. Personnel exiting the exterior asbestos control work area shall, at a minimum, vacuum their disposable coveralls with a HEPA vacuum, dispose of the coveralls in an OSHA approved asbestos waste disposal bag, and wash their exposed skin with soap and water prior to leaving the asbestos control area.
e. Do not allow dislodged cementitious wall panels or cooling fins to dry out. As it is removed, place the material in sealable plastic bags of 0.15 mm minimum thickness. Place sealed asbestos debris in second 0.15 mm plastic bag, appropriately labeled, and remove from abatement work area.
f. After removal of asbestos-containing material, wet-clean all surfaces in the abatement work area to remove residual accumulated material. Continue wet-cleaning until surfaces are visibly free of material.
g. Proceed to clearance testing following approval from PQP that abatement work area is visually free of asbestos-containing materials.

C. PROTECTION OF EXISTING WORK TO REMAIN

1. Perform work without damage or contamination of adjacent work. Where such work is damaged or contaminated as verified by the Contracting Officer using visual inspection or sample analysis, it shall be restored to its original condition or decontaminated by the Contractor at no expense to the Government as deemed appropriate by the Contracting Officer. This includes inadvertent spill of dirt, dust, or debris in which it is reasonable to conclude that asbestos may exist. When these spills occur, stop work immediately. Then clean up the spill. When satisfactory visual inspection and air sampling results are obtained from the PQP work may proceed at the discretion of the Contracting Officer.

2. Furnishings

a. Moveable furniture and equipment will be removed from the area of work by the Government before asbestos work begins. Should furnishings or equipment remain within the work area then the contractor shall cover and seal furnishings with 0.15 mm plastic sheeting.

3. Precleaning

a. Wet wipe and HEPA vacuum all surfaces potentially contaminated with asbestos prior to establishment of an enclosure.

D. ASBESTOS CONTROL AREA REQUIREMENTS

1. Negative Pressure Enclosure

a. Block and seal openings in areas where the release of airborne asbestos fibers can be expected. Establish an asbestos negative pressure enclosure with the use of curtains, portable partitions, critical barriers or other enclosures in order to prevent the escape of asbestos fibers from the contaminated asbestos work area. Provide local exhaust system in the asbestos control area. Openings will be allowed in enclosures of asbestos control areas for personnel and equipment entry and exit, the supply and exhaust of air for the local exhaust system and the removal of properly containerized asbestos containing materials. Replace local exhaust system filters as required to maintain the efficiency of the system.

E. AIR SAMPLING

1. Sampling of airborne concentrations of fibers shall be performed in accordance with 29 CFR 1926.1101 and as specified herein. Sampling performed in accordance with 29 CFR 1926.1101 shall be performed by the PQP. Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Monitoring may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate.

2. Sampling Prior to Asbestos Work

a. Provide area air sampling and establish the baseline one day prior to the masking and sealing operations for each removal site. Establish the background by performing area sampling in similar but uncontaminated sites in the building.

b. Sampling During Asbestos Work

1) The PQP shall provide personal and area sampling, unless area sampling will be conducted by a third party at the owner's discretion, as indicated in 29 CFR 1926.1101 and governing environmental regulations. In addition, provided the same type of work is being performed, provide area sampling at least once every work shift close to the work inside the enclosure, outside the clean room entrance to the enclosure, and at the exhaust opening of the local exhaust system. If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the increase, and notify the Contracting Officer immediately. Where alternate methods are used, perform personal and area air sampling

at locations and frequencies that will accurately characterize the evolving airborne asbestos levels.

c. Sampling After Final Clean-Up (Clearance Sampling)

1) Provide area sampling of asbestos fibers using Transmission Electron Microscopy (TEM) aggressive air sampling techniques as defined in AHERA (40CFR763, subpart E) regulations and establish an airborne asbestos concentration of less than an average of 70 structures per square millimeter after final clean-up but before removal of the enclosure or the asbestos work control area. After final cleanup and the asbestos control area is dry but prior to clearance sampling, the PQP shall perform a visual inspection in accordance with ASTM E 1368 to ensure that the asbestos control and work area is free of any accumulations of dirt, dust, or debris. Should any of the final samples indicate an average value higher than 70 structures per square millimeter, the Contractor shall take appropriate actions to re-clean the area and shall repeat the sampling and analysis at the Contractor's expense.

F. LOCK-DOWN

1. Prior to removal of plastic barriers and after pre-clearance clean up of gross contamination, the PQP shall conduct a visual inspection of all areas affected by the removal in accordance with ASTM E 1368. Inspect for any visible dust and debris. A post removal (lock-down) encapsulant shall then be spray applied to floors exposed in the removal area.

G. SITE INSPECTION

1. While performing asbestos engineering control work, the Contractor shall be subject to on-site inspection by the Contracting Officer who may be assisted by or represented by safety or industrial hygiene personnel. If the work is found to be in violation of this specification, the Contracting Officer or his representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the violation shall be at the Contractor's expense.

H. CLEAN-UP AND DISPOSAL

1. Housekeeping

a. Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. When asbestos removal is complete, all asbestos waste is removed from the work-site, and final clean-up is completed, the Contracting Officer will attest that the area is safe before the signs can be removed. After final clean-up and acceptable airborne concentrations are attained but before the HEPA unit is turned off and the enclosure removed, remove all pre-filters on the building HVAC system and provide new pre-filters. Dispose of filters as asbestos contaminated materials. Reestablish HVAC mechanical and electrical systems in proper working order. The Contracting Officer will visually inspect all surfaces within the enclosure for residual material or accumulated dust or debris. The Contractor shall re-clean all areas showing dust or residual materials. If re-cleaning is required, air sample and establish an acceptable asbestos airborne concentration after re-cleaning. The

Contracting Officer must agree that the area is safe in writing before unrestricted entry will be permitted. The Government shall have the option to perform monitoring to determine if the areas are safe before entry is permitted.

2. Title to Materials

a. All waste materials, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified in applicable local, State, and Federal regulations and herein.

3. Disposal of Asbestos

a. Procedure for Disposal

1) Collect asbestos waste, asbestos contaminated water, scrap, debris, bags, containers, equipment, and asbestos contaminated clothing which may produce airborne concentrations of asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g. double plastic bags 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet in accordance with 40 CFR 61-SUBPART M. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 0.15mm thick bags with the approved warnings and DOT labeling preprinted on the bag. The name of the waste generator and the location at which the waste was generated shall be clearly indicated on the outside of each container. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or State-approved asbestos landfill off Government property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be assigned by the Contracting Officer or his authorized representative. Procedure for hauling and disposal shall comply with 40 CFR 61-SUBPART M, State, regional, and local standards. Workers unloading the sealed drums shall wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

4. Asbestos Disposal Quantity Report

a. The contractor shall maintain and provide a waste manifest to record and report, to the Contracting Officer, the amount of asbestos containing material removed and released for disposal. Deliver the report for the previous day at the beginning of each day shift with amounts of material removed during the previous day reported in square feet as described initially in this specification and in cubic feet for the amount of asbestos containing material released for disposal.

b. Allow the PQP to inspect, record and report the amount of asbestos containing material removed and released for disposal on a daily basis.

-- END OF SECTION --

SECTION 15010 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 RULES AND REGULATIONS

A. Work and materials shall conform to and be executed, inspected and tested in accordance with the latest edition of applicable Federal, State and local codes and with the other governing rules and regulations of Federal, State and local governmental agencies.

B. Specific codes and standards which will apply to this installation are listed in applicable specification sections.

1.3 SUMMARY

A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Division 15. It expands and supplements the requirements specified in Division 1.

1. Submittals.
2. Coordination drawings.
3. Record documents.
4. Maintenance Manuals.
5. Rough-ins.
6. Mechanical installations.
7. Cutting and patching.

B. Related Sections: The following sections contain requirements that relate to this section:

1. Division 15 Section "Division of Work, Divisions 15/16", for electrical work divided between Division 15 and Division 16 responsibility.
2. Division 15 Section "Electrical Requirements for Mechanical Equipment", for factory-installed motors, controllers, accessories, and connections.
3. Division 15 Section "Basic Mechanical Materials and Methods", for materials and methods common to the remainder of Division 15, plus general related specifications including:

1.4 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1 Section "Coordination", to a scale of 1/4 inch = 1 foot - 0 inch or larger; detailing major elements, components, and

systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the proposed locations of piping, ductwork, equipment, and materials. Include the following:

1. Clearances for installing and maintaining insulation.
2. Clearances for servicing and maintaining equipment, including tube removal, filter removal and space for equipment disassembly required for periodic maintenance.
3. Equipment connections and support details.
4. Exterior wall and foundation penetrations.
5. Fire-rated wall and floor penetrations.
6. Sizes and location of required concrete pads and bases.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls and their relationship to other penetrations and installations.

1.5 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1 Section "Project Closeout". In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.) Valve location diagrams, complete with valve tag chart. Refer to Division 15 Section "Mechanical Identification." Indicate actual inverts and horizontal locations of underground piping.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.6 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section "Project Closeout". In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Handle equipment carefully to prevent damage, breaking, denting and scoring. Do not install damaged equipment or components; replace with new.

C. Store equipment in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

D. Comply with Manufacturer's rigging and installation instructions for unloading of equipment and moving of equipment to final location.

E. Any specific additional delivery, storage and handling requirements are listed in the applicable specification sections.

1.8 SUBMITTALS

A. Furnish submittals in compliance with Division 1 requirements for the following:

1. Piping Materials
2. Valves
3. Meters and Gauges
4. Supports and Anchors
5. Mechanical Identification
6. Vibration and Seismic Control
7. Mechanical Insulation
8. Water Distribution Piping
9. Hydronic Specialties
10. HVAC Pumps
11. Pipe Cleaning
12. Heat Exchangers
13. Control Systems
14. Sequence of Operation
15. Testing, Adjusting and Balancing

B. Submittals shall include the following:

1. Product Data: Submit product data, including rated capacities, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
2. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances, methods of assembly of components, and location and size of each field connection.
3. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder type wiring diagrams for control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field installed.
4. Maintenance Data: Submit maintenance and operating data. Include this data in maintenance manual in accordance with requirements of Division 1.

C. Any specific additional submittal requirements are listed in the applicable specification sections.

D. Submittals shall be submitted in groups by systems. For example, all submittals pertaining to the generation of chilled water shall be submitted simultaneously in one package. This would include, but not be limited to:

1. Chilled water pump.
2. Cooling tower.
3. Condenser water strainer.
4. Condenser water pump.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

3.2 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Coordinate connection of new mechanical systems with existing mechanical systems, equipment removals and relocations with the Owner. Perform this work at such times to ensure that periods of shut-down are acceptable to the Owner.
7. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
8. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
9. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.
10. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING". In addition to the requirements specified in Division 1, the following requirements apply:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

2. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

   a. Uncover Work to provide for installation of ill-timed Work.
   b. Remove and replace defective Work.
   c. Remove and replace Work not conforming to requirements of the Contract Documents.
   d. Remove samples of installed Work as specified for testing.
   e. Install equipment and materials in existing structures.
   f. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

B. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, plumbing fixtures and trim, insulation, chiller, pump and other mechanical equipment and items made obsolete by the new Work.

C. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

E. Patch existing and newly finished surfaces and building components using new materials matching existing materials and experienced installers. Installers' must be competent and experienced in the materials and methods required for the surface and building components being patched.

3.4 COMMISSIONING

A. The execution of this contract includes the system's commissioning by an independent commissioning agent.

B. Cooperation with the commissioning agent.

1. The contractor and all vendors shall cooperate with the commissioning agent in the execution of all Commissioning activities by providing manpower, equipment, written submittals and all other support required by Section 01810 of these specifications. It shall be the responsibility of all parties to this work to review and comply with these requirements and the requirements of the commission plan issued for this project.

END OF SECTION 15010

SECTION 15025 - DIVISION OF WORK, DIVISION 15/16

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section delineates the division of work between Division 15 and Division 16.

B. Specific work to be done under Division 16 is hereinafter listed or described. All other electrical work necessary for the operation of Division 15 equipment shall be performed under Division 15.

C. All motor control centers and all individual and grouped motor starters shall be furnished and installed under Division 16 with the exception of: Variable speed drives; Division 15 equipment specified with integral starters.

D. All connections to motors, motor starters, and terminal connections to equipment shall be performed under Division 16 with the exception that Division 15 equipment specifically specified with wired components shall receive only a terminal connection under Division 16.

E. All thermal - remote selector - disconnect switches and remote push-button stations shall be furnished and wired by Division 16.

F. All relays, timers, 7 day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric and electric-pneumatic switches, aquastats, freezestats, line and low voltage thermostats, and solenoid valves shall be furnished, installed and wired by Division 15.

G. All wiring required for "Controls" including any wiring not indicated on Drawings shall be furnished and installed by Division 15.

H. All Direct Digital Control Systems and wiring shall be furnished and installed by Division 15 according to the Division 16 Drawings. Refer to Division 15 Sections "Controls" and "Sequence of Operation". Division 16 shall provide all switch leg wiring and power wiring to lighting relay control panels.

I. Division 16 shall provide 20A - 120V circuit breakers in either normal or emergency power panels for all DDC-controllers and all other control system components.

J. Horsepowers for all motors are indicated on Drawings.

END OF SECTION 15025

SECTION 15030 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 16.

1.2 SUMMARY

A. This section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment and variable frequency drives. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

1.3 REFERENCES

A. NEMA Standards MG 1: Motors and Generators

B. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and assemblies.

C. NEMA Standard 250: Enclosures for Electrical Equipment

D. NEMA Standard KS 1: Enclosed Switches

E. Comply with National Electrical Code (NFPA 70.)

1.4 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

1.5 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

B. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Electrical components/materials shall be labeled by a NRTL. The term “NRTL” shall be as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Motor Starter Characteristics:

1. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs, or units in hazardous locations which shall have proper NEMA class and division.
2. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.

B. Manual switches shall have:

1. Pilot lights and extra positions for multi-speed motors.
2. Overload protection: melting alloy type thermal overload relays.

C. Magnetic Starters:

1. Maintained contact push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
2. Trip-free thermal overload relays, each phase.
3. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 15 Controls sections.
4. Built-in 120 volts control circuit transformer, fused from line side, where service exceeds 240 volts.
5. Externally operated manual reset.
6. Under-voltage release or protection.

D. Motor connections:

1. Flexible metal conduit, except where plug-in electrical cords are specifically indicated. Liquid-tight flexible metal conduit shall be used in damp or wet locations.

E. Disconnect Switches:

1. Fusible switches: fused, (Class RK-1) each phase; heavy duty; horsepower rated; non-teasible quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; ground wire lug brazed to enclosure; capacity and characteristics as indicated.
2. Non-fusible switches: for equipment 2 horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment larger than 2 horsepower, switches shall be the same as fusible type.
3. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs, or units in hazardous locations which shall have proper NEMA class and division.

4. Amps Interrupting Capacity (AIC) – Match fuse or upstream protection device.

2.2 VARIABLE FREQUENCY DRIVES

A. General: Variable torque AC drive consisting of a solid state adjustable frequency controller (AFC) and a performance matched energy efficient motor. The manufacturer shall provide, coordinate and start-up the drive package to ensure both proper application of the motor to the controller and to the system. The variable speed drive shall be fully digital pulse with modulation (PWM) utilizing very large scale integration (VLSI) techniques, as well as surface mount technology for increased reliability. The entire VFD Package including all options shall be in one common cabinet with the entire assembly UL approved and listed.

B. Adjustable frequency Controller: Shall convert service voltage, three phase, 60 hertz utility power to adjustable voltage/frequency, three phase, AC power for stepless motor control 10 percent to 110 percent of base speed.

C. Designed and constructed to operate within the following service conditions:

1. Elevation: to 3,300 feet without derating.
2. Ambient Temperature Range: 0 degrees C to 40 degrees C.
3. Atmosphere: Non-condensing relative humidity to 95 percent.
4. AC Line Voltage Variation: -10 percent to +10 percent and +/-2 percent frequency.
5. Ride-through power sags up to 500 mSec without a controller trip.

D. AFC shall be selected to be compatible with motor maximum FLA nameplate rating. All components shall be horsepower rated.

E. Circuits shall provide time derivative variable voltage and variable current protection for semi-conductors. AFC shall be capable of starting into a rotating load without delay. Protective circuits shall cause instantaneous trip (IET) should any of the following faults occur:

1. 110 percent of controller maximum sine wave current rating is exceeded for longer than one (1) minute.
2. Output phase to phase short circuit condition.
3. Total ground fault protection under any operating condition.
4. High input line voltage.
5. Low input line voltage.
6. Loss of input phase.
7. External fault (this protective circuit shall permit by means of terminal strip, wiring of remote N.C. safety contacts such as high duct static pressure, fire or smoke safety, etc., to shut down the drive).

F. The following adjustments shall be available in the controller:

1. Maximum frequency (15 to 120 Hz) factory set at 60 Hz.

2. Minimum frequency (5 to 60 Hz) factory set at 6 Hz.
3. Adjustable Acceleration (0.1 to 360 seconds) factory set at 20 seconds.
4. Adjustable Deceleration (0.1 to 360 seconds) factory set at 20 seconds.
5. Volts/Hertz ratio factory set for service voltage at 60 Hz.
6. Voltage offset or boost factory set at 100 percent torque.
7. Current limit (50 percent to 100 percent sine wave current rating) factory set at 100 percent current.

G. Door mounted operator control of AFC shall be furnished with a micro-processor based command center with a membrane keypad which allows auto/manual, start/stop, manual speed control, programming, and visual display of the units operating parameters. The microprocessor system shall be password protected and provide full monitoring, control and diagnostics.

1. In automatic mode, controller shall follow an external signal and respond to remote start-stop contact wired to terminal strip and all safety interlocks.
2. Digital display shall be door mounted to indicate power on, drive faults, motor running and external faults.
3. While in auto mode the controller shall attempt to three automatic restarts (user selectable) after a power outage, drive fault or external fault. If drive does not successfully come back on line after the programmed tries it shall remain off on IET until operator diagnoses cause of shut down and manually re-establishes drive operation in the bypass or AFC mode of operation.
4. Integral annunciator contact for customer remote indication of drive fault conditions.
5. An integral "External Fault" protective shutdown circuit shall be provided for interface of firestat, smoke detectors, duct high limit pressure switches, etc. These safety interlocks shall provide shutdown of the system while operating the VFD or By-pass mode.
6. Voltage, current and frequency display: Shall be provided to digitally indicate the output voltage, output frequency and output current.
7. Built-in Diagnostics: Shall provide a quick means for monitoring the different signals within the AFC for start-up and troubleshooting. The diagnostics shall indicate internal and external faults and provide digital display of inverter system faults.

H. Input Power Parameters:

1. The Variable frequency Controller shall accept 208/230 Volts AC three-phase, 60 Hz for 230V services, and 460 Volts AC three-phase, 60 Hz for 460 volts series. Variations of up to +/- 10% of line voltage and +/-2 Hz of line frequency shall be permitted without the drive shutting down on a fault.
2. The drive input circuitry shall not generate line notches or large voltage transients on the incoming line.

I. Compliance to the latest edition of IEEE 519

1. The VFD manufacturer shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with the latest edition of IEEE standard 519, Guide for Harmonic Control and Reactive Compensation for Static Power Converters. The acceptance of this calculation must be completed prior to VFD installation.
2. Prior to installation, the VFD manufacturer shall provide the estimated total harmonic distortion (THD) caused by the VFD's. The results shall be based on a computer aided circuit simulation of the total actual system, with information obtained from the power provided and the user.

J. Manual Bypass With Magnetic Contacts:

1. Manual bypass with magnetic contactors shall provide all the circuitry necessary to safely transfer the motor from the AFC to the power line, or from the line to the controller while the motor is at zero speed.
2. Two motor contacts, electrically interlocked, shall be utilized. One contactor shall be between the controller output and the motor, controlled by the controller regulator and the other one shall be between the bypass power line and the motor, providing across the line starting. Motor protection is to be provided in both the "controller" mode and the "bypass" mode by a thermal motor overload relay. The control logic shall allow common start/stop and all protective circuit commands in the "controller" mode and the "bypass" mode. A main power input disconnect switch shall be capable of positive shut-down of all input power to both the bypass circuitry and the AFC. This main input disconnect switch shall have provisions for pad locking in the off position for operator safety.
3. A second input disconnect switch shall allow isolation of the AFC from input power while allowing the system to operate in the bypass mode. This disconnect shall provide the ability to safely troubleshoot and test the controller, both energized and de-energized, while operating in the "bypass mode. All components shall mount within the common controller enclosure as a factory unitized package.

K. Enclosure: Shall require front access only with both top and bottom cable entry possible and shall be NEMA 1 design.

L. General options/modifications shall be designed to fit in the standard enclosure while maintaining the AFC UL listing. The complete unit as a total assembly shall be UL approved and labeled.

M. General options/modifications shall include:

1. Isolated Process Control Interface: Shall enable the AFC to follow a 0-5, 1-5, 4-20, 10-50, ma; 0-4, 0-8, 0-10 VDC grounded or ungrounded signal from a process controller.
2. Input line reactors to provide additional line inductance which reduces nuisance trips from line surges, line notching and voltage distortion. (Refer to compliance with IEEE 519-1991 parameters above).

3. Motor Overload: Shall contain a thermal overload relay designed to protect one AC motor operated on AFC output from extended overload operation. This shall be designed to mount internal to the AFC enclosure.

N. Quality assurance controls, procedures and tests.

1. Integrated circuits tests shall include 168 hours burn-in screening at 145 degrees C according to MIL-STD-8813B, stabilization baking and temperature cycling from 150 degrees C to -40 degrees C.
2. Small signal semi-conductors shall be lot samples HTRB per MIL-STD-105D (1 percent AGL).
3. All SCR device assemblies of individual heatsink construction shall be electrically curve traced. Each assembly shall be loaded to 125 percent of its rated full load amperes and run for five minutes.
4. Electronic printed circuit board assemblies shall be temperature cycled for 24 hours between 5 degrees C and 85 degrees C.
5. AFC shall be functionally tested under motor load and then cycled under load for several hours.

O. Manufacturers: Subject to compliance with requirements, provide variable frequency drives of one of the following:

1. AC Tech
2. Allen bradley
3. Asea Brown Boveri
4. Danfoss Graham
5. Reliance Electric Co.

PART 3 - EXECUTION

3.1 CLOSEOUT PROCEDURES

A. Provide services of manufacturer's technical representative for one 8-hour day to instruct Owner's personnel in operation and maintenance of variable frequency drives.

1. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END OF SECTION 15030

SECTION 15032 – ELECTRIC HEAT TRACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

A. This Section includes a complete UL-listed system of heating cables, components, and controls to prevent pipes from freezing.

B. Related Sections: The following Sections contain requirements that relate to this section.

1. Division 15 Section "Mechanical Insulation" for insulation of pipes following installation of electric heat tracing.
2. Other Division 15 sections for individual piping systems requiring electric heat tracing.
3. Other Division 16 sections for power connections to electric heat tracing.

1.3 SUBMITTALS

A. Refer to Section 15010 “Basic Mechanical Requirements”.

B. Shop drawings from manufacturer detailing dimensions, required clearances, components and location and size of each field connection.

C. Incorporate electric heat tracing into coordination drawings in accordance with Division 15 Section "Basic Mechanical Requirements."

D. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.

E. Product certificates signed by manufacturers of electric heat tracing certifying that their products comply with specified requirements.

F. Field quality control test reports specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE

A. UL Compliance: Electric heat tracing shall be listed by Underwriters' Laboratories.

B. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Electric heat tracing shall be listed by a NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15010 "Basic Mechanical Requirements".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide electric heat tracing products by one of the following:

1. Raychem, XL-Trace

2.2 ELECTRIC HEAT TRACING - GENERAL

A. The self-regulating heating cable shall consist of two (2) 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned-copper and an outer jacket of fluoropolymer (-CT), as required per Section 427-23 of the NEC-1996.

B. In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 40 degrees F pipe temperature operation to 150 degrees F pipe temperature operation.

C. The heating cable shall operate on line voltages of 120 and 208 volts without the use of transformers as indicated on drawings.

D. The heating cable shall be sized according to the table below. The required heating cable output rating is in watts per foot at 50 degrees F. (Heating cable selection based on 1" fiberglass insulation on metal piping.).

Pipe Size	Minimum Ambient -10 Degrees F	Temperatures -20 Degrees F
3 in or less	5 watts	5 watts
4 in	5 watts	8 watts
6 in	8 watts	8 watts
8 in	2 strips - 5 watts	2 strips - 8 watts
12 in to 14 in	2 strips - 8 watts	2 strips - 8 watts
14 in to 20 in	3 strips – 10 watts	3 strips – 10 watts
20 in to 30 in	4 strips – 14 watts	4 strips – 14 watts

E. Power connection, end seal, splice, and fee kit components shall be applied in the field.

F. Heating cable circuit shall be protected by a ground fault device for equipment protection. This requirement is in accordance with Section 427-22 of the NEC-1996. Coordinate with Division 16.

2.3 SYSTEM CONTROL

A. System shall be enabled from a signal from the BAS.

B. Thermostatic Control-Bulb Sensing: The system shall be controlled by a bulb sensing thermostat AMC-1B set at 40 degrees F either directly or through an appropriate contactor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Apply the heating cable linearly on the pipe after piping has been successfully pressure-tested. Secure the heating cable to piping with cable ties or fiberglass tape.

B. Apply "Electric Traced" signs to the outside of the thermal insulation.

3.2 TESTS

A. After installation and before and after installing the thermal insulation, subject heating cable to testing using a 2500 Vdc Megger. Minimum insulation resistance shall be 20 to 1000 megohms regardless of length.

3.3 COMMISSIONING

A. Refer to Section 01810 “Building System Commissioning” for additional requirements.

END OF SECTION 15032

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Requirements specified in Division 15 Section "Basic Mechanical Requirements" apply to this Section.

1.2 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:

1. Mechanical equipment nameplate data.
2. Miscellaneous metals for support of mechanical materials and equipment.
3. Prime painting of miscellaneous metals and pipe hangers.
4. Joint sealers for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
5. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 2 Section "Selective Demolition" for demolition requirements.
2. Division 9 Section "Painting" for prime paint materials.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer for the installation and/or application joint sealers, access panels, and doors.

B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

C. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 SEQUENCE AND SCHEDULING

A. Coordinate the shut-off and disconnection of utility services with the Owner and the utility company.

PART 2 - PRODUCTS

2.1 MECHANICAL EQUIPMENT NAMEPLATE DATA

A. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

2.2 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout, recommended for interior and exterior applications.

F. Fasteners: Zinc-coated, type, grade, and class as required.

G. Prime Paint: Refer to Division 9 Section "Painting" for prime paint materials, preparation and application requirements.

PART 3 - EXECUTION

3.1 SELECTIVE DEMOLITION

A. Perform demolition operations in accordance with Division 2 Section "Selective Demolition."

3.2 EXCAVATION AND BACKFILLING

A. Perform excavation and backfilling, operations in accordance with Division 2 Section "Earthwork."

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Prepare metal and apply one coat of prime paint in accordance with paint manufacturers recommendations and Division 9 Section "Painting". Touch-up shop applied prime paint damaged during final assembly and installation. All rust occurring to metals during storage and installation shall be sand blasted prior to "touch up" painting.

C. Field Welding: Comply with AWS "Structural Welding Code."

D. All exterior steel support and anchorage components shall be hot dipped galvanized.

3.4 APPLICATION OF JOINT SEALERS

A. Install sealant, including forming, packing, and other accessory materials, to fill openings around mechanical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

END OF SECTION 15050

SECTION 15055 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

A. This Section specifies piping materials and installation methods common to more than one section of Division 15 and includes joining materials, piping specialties, and basic piping installation instructions.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 2 and other Division 15 sections for individual piping systems and the piping materials and installation methods peculiar to them.
2. Division 15 Section "Valves" and other Division 15 sections for individual piping systems for related valve materials and installation methods.
3. Division 15 Section "Supports and Anchors."
4. Division 15 Section "Mechanical Identification."
5. Division 15 Section "Vibration and Seismic Control."

1.3 SUBMITTALS

A. Refer to Section 15010 "Basic Mechanical Requirements".

1.4 QUALITY ASSURANCE

A. Safety Codes: Comply with all safety codes which govern the installations of welded piping.

B. Welder's Qualifications: All welders shall be qualified in accordance with ANSI Code B31.1 for Power Piping and ANSI Code B31.9 for Building Service Piping.

C. Welding procedures and testing shall comply with ANSI Code B31.1 - Standard Code for Power Piping, and The American Welding Society, Welding Handbook and ANSI Code B31.9 - Standard Code for Building Service Piping.

D. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

C. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

D. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide piping materials and specialties from one of the following:

1. Pipe Escutcheons:

   a. Chicago Specialty Mfg. Co.
   b. Sanitary-Dash Mfg. Co.
   c. McGuire

2. Dielectric Unions:

   a. Perfection Corp.
   b. Watts Regulator Co.
   c. Epco Sales, Inc.

3. Dielectric Waterway Fittings:

   a. Epco Sales, Inc.
   b. Victaulic Company of America
   c. Anvil International

4. Y-Pattern Strainers:

   a. Armstrong Machine Works.
   b. Hoffman Specialty ITT; Fluid Handling Div.
   c. Metraflex Co.
   d. Spirax Sarco.
   e. Watts Regulator Co.

5. Basket Strainers:

   a. Josam Co.
   b. Metraflex Co.
   c. Smith (Jay R.) Mfg. Co.

d. Spirax Sarco, Inc.
e. Victaulic Co. of America

6. Mechanical Sleeve Seals:

a. Thunderline Corp**.**

2.2 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 15 for specifications on piping and fittings relative to that particular system.

2.3 JOINING MATERIALS

A. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

B. Brazing Materials: Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

C. Soldering Materials: Refer to individual piping system specifications for solder appropriate for each respective system.

D. Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.4 PIPING SPECIALTIES

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions: Malleable-iron or bronze, Class 150 for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

C. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion. Dielectric unions shall not be used in water or steam systems.

D. Dielectric Waterway Fittings: Electroplated steel or brass nipple, with an inert of non-corrosive, thermoplastic lining. Fitting shall be rated at 300 PSI and shall be compatible with glycol solutions used in heating systems with temperatures up to 225 degrees F.

E. Y-Type Strainers: Provide strainers full line size of connecting piping, with ends matching piping system materials. Screens shall be Type 304 stainless steel, with 3/64 inch perforations at 233 per square inch.

1. Provide strainers with 125 psi working pressure rating for low pressure applications, and 250 psi pressure rating for high pressure application.
2. Threaded Ends, 2 Inch and Smaller: Cast-iron body, or bronze, screwed screen retainer with centered blowdown fitted with pipe plug.
3. Threaded Ends, 2-1/2 Inch and Larger: Cast-iron body or bronze, bolted screen retainer with off-center blowdown fitted with pipe plug.
4. Flanged Ends, 2-1/2 Inch and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
5. Butt Welded Ends, 2-1/2 Inch and Larger For Low Pressure Application: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.

F. Basket Stainers: Cast-iron body, 125 psi flanges, bolted-type or yoke-type cover with removable noncorrosive perforated strainer basket having 1/8 inch perforations and lift-out handle.

G. Sleeves:

1. Sheet-Metal Sleeves: 10 gauge, galvanized sheet metal, round tube closed with welded longitudinal joint, for sleeves 6 inches and larger.
2. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A53, Grade A, for sleeves 4 inches and smaller.

H. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 INSTALLATIONS

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination

drawing submittals.

B. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

D. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation.

E. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

F. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.

G. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inch and larger shall be sheet metal.

H. Install seismic supports per Division 15 Section "Vibration and Seismic Control".

I. Install pipe escutcheons at all exposed pipe penetrations through walls.

3.3 FITTINGS AND SPECIALTIES

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install strainers as indicated. Install blowdown valve on strainer outlet.

D. Install unions adjacent to each control valve, and at the final connection to each piece of equipment having 2 inch and smaller connections, and elsewhere as indicated.

E. Install Flanges in piping 2-1/2 inch and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.

F. Install dielectric unions to connect piping materials of dissimilar metals in piping systems.

G. Install dielectric waterway fittings to connect piping materials of dissimilar metals in wet piping systems.

3.4 JOINTS

A. Steel Pipe Joints:

1. Pipe 2 Inch and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant

suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.

2. Pipe Larger Than 2 Inch:

   a. Weld pipe joints (except for exterior water service pipe) in accordance with ANSI Code B31.1 for Power Piping and ANSI Code B31.9 for Building Service Piping.
   b. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
   c. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ANSI Code B31.1 for Pressure Piping and ANSI Code B31.9 for Building Service Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:

1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI Code B31.1 - Standard Code for Power Piping, ANSI Code B31.9 - Standard Code for Building Service Piping and ANSI Code B9.1 - Standard Safety Code for Mechanical Refrigeration.
2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Joints for other piping materials are specified within the respective piping system sections.

3.5 FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

END OF SECTION 15055

SECTION 15100 - VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."
3. "Basic Piping Materials and Methods."

1.2 SUMMARY

A. This Section includes general duty valves common to most mechanical piping systems.

1. Special purpose valves are specified in individual piping system specifications.

B. Valve tags and charts are specified in Division 15 Section "MECHANICAL IDENTIFICATION."

1.3 SUBMITTALS

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Comply with the requirements specified in Division 1 Section "MATERIAL, PRODUCTS AND EQUIPMENT", under "Source Limitations."

B. American Society of Mechanical Engineers (ASME) Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the various MSS Standard Practices referenced.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Preparation For Transport: Prepare valves for shipping as follows:

1. Ensure valves are dry and internally protected against rust and corrosion.
2. Protect valve ends against damage to threads, flange faces, and weld-end preps.
3. Set valves in best position for handling. Set globe and gate valves closed to prevent rattling; set ball valves open to minimize exposure of functional surfaces; set butterfly valves closed or slightly open; and block swing check valves in either closed or open position.

C. Storage: Use the following precautions during storage:

1. Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.
2. Protect valves from weather. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.

D. Handling: Use a sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products from one of the following:

1. Ball Valves

a. Conbraco Industries, Inc.; Apollo Division
b. Lance Valves
c. Hammond Valve Corporation
d. Milwaukee Valve Company, Inc.
e. NIBCO Inc.
f. Stockham, A Crane Co.
g. Victaulic Company of America

2. Butterfly Valve (Standard):

a. GrinnellCorp.
b. Hammond Valve Corporation.
c. Keystone Valve USA, Inc.
d. Milwaukee Valve Company, Inc.
e. NIBCO Inc.
f. Stockham, A Crane Co.

g. Victaulic Company of America.

3. Swing Check Valve:

a. Hammond Valve Corporation.
b. Milwaukee Valve Company, Inc.
c. NIBCO Inc.
d. Stockham, A Crane Co.
e. Victaulic Company of America.

4. Wafer Check Valves

a. Stockham, A Crane Co.
b. Metraflex Company
c. Milwaukee Valve Company, Inc.
d. NIBCO Inc.
e. Victaulic Company of America.

5. Lift Check Valves:

a. Crane Company.
b. Milwaukee Valve Company, Inc.
c. NIBCO Inc.
d. Stockham, A Crane Co.

2.2 VALVE FEATURES, GENERAL

A. Valve Design: Rising stem or rising outside screw and yoke stems.

1. Nonrising stem valves may be used where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators: Provide the following special operator features:

1. Handwheels, fastened to valve stem, for valves other than quarter turn.
2. Lever handles, on quarter-turn valves 6 inch and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for every 10 plug valves.
3. Chain-wheel operators, for valves installed 8 feet or greater above finished floor elevation.
4. Gear drive operators, on quarter-turn valves 8 inch and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

G. End Connections: As indicated in the valve specifications.

1. Threads: Comply with ANSI B1.20.1.
2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
3. Solder-Joint: Comply with ANSI B16.18.
4. **Caution: Where soldered end connections are used, use solder having a melting point below 461 deg F. Extreme caution shall be used to prevent seat damage on ball valves. Use threaded or flanged connections when valves are installed in brazed piping systems.**

2.3 BALL VALVES

A. Ball Valves, Up to 3 inch: Class 150, 600 PSI CWP pressure, two-piece construction; ASTM B 584 bronze body, threaded or soldered ends, conventional port, stainless steel ball, "Teflon" or "PTFE" seats and seals, blowout-proof stainless steel stem, and vinyl-covered steel handle. Provide extended stems for valve handles on all insulated lines.

1. Service Applications: Condenser water, chilled water, domestic cold water.

2.4 BUTTERFLY VALVES

A. Butterfly Valves, 2-1/2 Inch and Larger: MSS SP-67; Class 150, 200 PSI CWP, ASTM A 126 cast iron body, field replaceable "EPDM" seat, aluminum-bronze disc, stainless steel stem. Gear operators with position indicator. Provide lug type except as otherwise indicated. Drill and tap valves on dead-end service or requiring additional body strength.

1. Service Applications: Condenser water, chilled water, domestic cold water.

2.5 CHECK VALVES

A. Swing Check Valves, 2 Inch and Smaller: MSS SP-80; Class 125, 200 PSI CWP, ASTM B 62 cast-bronze body and cap, horizontal swing, Y-pattern, rotating bronze disc, threaded or solder ends. Provide valves capable of being reground while the valve remains in the line.

1. Service Applications: Condenser water, chilled water, domestic cold water.

B. Swing Check Valves, 2-1/2 Inch and Larger: MSS SP-71; Class 125, 200 PSI CWP, ASTM A 126 cast iron body and bolted cap, horizontal swing, bronze disc or cast-iron disc with bronze disc ring, flanged ends. Provide valves capable of being refitted while the valve remains in the line.

1. Service Applications: Condenser water, chilled water, domestic cold water.

C. Wafer Check Valves: Class 125, 250 PSI CWP, ASTM A 126 cast-iron body, replaceable bronze seat, non-slam design lapped and balanced twin bronze flappers with stainless steel trim and torsion spring. Provide valves designed to open and close at approximately one foot differential pressure. Install wafer check valves at the discharge of all water pumps.

1. Service Applications: Condenser water, chilled water, domestic cold water.

D. Lift Check Valves, 2 Inch and Smaller: Class 125; 200 PSI CWP, ASTM B 62 cast-bronze body and cap; horizontal or angle pattern, lift-type valve, stainless steel spring, bronze disc holder with renewable "Teflon" disc, threaded ends. Provide valves capable of being refitted and ground while the valve remains in the line.

1. Service Applications: Condenser water, chilled water, domestic cold water.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior through the end ports for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks used to prevent disc movement during shipping and handling.

B. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the shipping position.

C. Examine threads on both the valve and the mating pipe for form (i.e., out-of-round or local indentation) and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

E. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.

F. Replace defective valves with new valves.

3.2 VALVE INSTALLATIONS

A. General Application: Use ball and butterfly valves for shut-off duty; ball valves for throttling duty. Refer to piping system specification sections for specific valve applications and arrangements.

B. Locate valves for easy access and provide separate support where necessary. Where valves

are located 8 feet or greater above finished floors in mechanical rooms, chain operators shall be provided down to 6 foot, 6 inch level.

C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.

D. Install valves in horizontal piping with stem at or above the center of the pipe.

E. Install valves in a position to allow full stem movement.

F. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.
2. Wafer Check Valves: Horizontal or vertical position, between flanges.
3. Lift Check Valve: With stem upright and plumb.

3.3 SOLDER CONNECTIONS

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket in same manner.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Open valves to full open position.

E. Remove the cap and disc holder of swing check valves having composition discs.

F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.

G. Apply heat evenly to outside of valve around joint until solder will melt upon contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.4 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.5 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.6 FIELD QUALITY CONTROL

A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.7 ADJUSTING AND CLEANING

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

END OF SECTION 15100

SECTION 15135 - METERS AND GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."
3. "Basic Piping Materials and Methods."

1.2 SUMMARY

A. This Section includes the following types of meters and gauges:

1. Temperature gauges and fittings.
2. Pressure gauges and fittings.
3. Flow meters.
4. BTU meters.

B. Related Sections: The following sections contain requirements that relate to this section:

1. Division 15 Section "Water Distribution Piping" for water meters.

C. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 15 sections.

1.3 SUBMITTALS

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Product data for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated.

C. Product certificates signed by manufacturers of meters and gauges certifying accuracies under specified operating conditions and products' compliance with specified requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bimetal Dial Thermometers and Wells:
   a. March Instruments
   b. Trerice (H.O.) Co.
   c. Weiss Instruments, Inc.
   d. Weksler Instruments Corp.
2. Pressure Gauges and Accessories:
   a. Marsh Instruments
   b. Trerice (H.O.) Co.
   c. Weiss Instruments, Inc.
   d. Weksler Instruments Corp.
3. Venturi-Type Flow Measurement System; for all pipe sizes:
   a. Armstrong Pumps, Inc.
   b. Gerand Engineering Co.
4. BTU Meters:
   a. Data Industrial Corp.
   b. ISTA Energy Systems Corp.
   c. Monitoring Systems & Controls, Inc.
   d. Onicon

2.2 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

B. Scale range: Temperature ranges for services listed as follows:
   1. Condenser Water: 0 to 160 deg. F with 2-degree scale divisions.
   2. Chilled Water: 0 to 100 deg. F with 2-degree scale divisions.

2.3 BIMETAL DIAL THERMOMETERS

A. Type: Direct mounted, bimetal, universal angle.

B. Case: Stainless steel, acrylic plastic lens, 5 inch diameter.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Element: Bimetal coil.

E. Scale: Satin faced, nonreflective aluminum, permanently etched marking.

F. Stem: Stainless steel for separable socket, length to suit installation.

2.4 THERMOMETER WELLS

A. Thermometer Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.5 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection.

B. Case: Drawn steel, phenolic plastic or brass, acrylic plastic lens, 4-1/2 inch diameter.

C. Connector: Brass, 1/4 inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:

1. All fluids: 2 times operating pressure.

2.6 PRESSURE GAUGE ACCESSORIES

A. Syphon: 1/4 inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4 inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.7 FLOW METERS, GENERAL

A. Flow rate of elements and meters shall be same as connected equipment or system.

B. Include flow meter readout kit for each type of flow element. Readout kit to include meter, hoses and carrying case.

2.8 VENTURI-TYPE FLOW ELEMENTS - FOR ALL PIPE SIZES

A. Type: Differential-pressure venturi type, designed for installation in piping.

B. Construction: Bronze, brass or cadmium-plated steel with brass fittings and attached tag with flow conversion data. Ends shall be threaded for 2 inch and smaller elements and

flanged or welded for 2-1/2 inch and larger elements.

2.9 BTU METERS

A. Type: BTU meters consisting of turbine wheel flow meter, 2 temperature sensors, BTU monitor, integral stop valves, strainer, and magnetic trap.

B. BTU Monitor:

1. Display: The display shall contain two lines of sixteen alphanumeric characters. The operator shall be able to configure the display to show any combination of flow rate or total, energy rate or total, temperature inputs, temperature differential or relay status.
2. Programming shall be menu driven. A software lock shall allow the operator to enter a password that prevents changing totals, calibration information, or control settings.
3. The monitor shall also contain a self-diagnostic program to assist the operator in trouble shooting.
4. Provide optional display backlighting with adjustable contrast.
5. DDC Interface: Provide communications interface with DDC system.

C. Turbine Assembly: Turbine, strainer and stop valves shall be bronze construction rated for 125 psig working pressure at 250 deg F.

D. Temperature Ranges: 40 to 250 deg F (5 to 120 deg C).

E. Accuracy: Plus or minus 1 percent.

2.10 TEST PLUGS

A. Test Plugs shall be nickel-plated brass body, with 1/2 inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8 inch O.D. probe assembly from a dial-type thermometer or pressure gauge. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:

1. Air, Water, Oil, and Gas, 20 to 200 deg F: Neoprene.
2. Air and Water, minus 30 deg to 275 deg F: EPDM.

C. Test Kit: Provide test kit consisting of 1 pressure gauge, gauge adapter with probe, 2 bimetal dial thermometers, and carrying case.

D. Ranges of pressure gauge and thermometers shall be approximately 2 times systems operating conditions.

PART 3 - EXECUTION

3.1 THERMOMETERS INSTALLATION

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Install in the following locations and elsewhere as indicated, especially on the flow and control schematics:

1. At inlet and outlet of each hydronic chiller.
2. At inlet and outlet of each hydronic heat exchanger.

C. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.2 INSTALLATION OF PRESSURE GAUGES

A. Install pressure gauge in piping tee with pressure gauge valve, located on pipe at most readable position.

B. Install in the following locations, and elsewhere as indicated, especially on the flow and control schematics.

1. At suction and discharge of each pump.
2. At chilled water and condenser water inlets and outlets of chillers.

C. Pressure Gauge Needle Valves: Install in piping tee with snubber.

3.3 INSTALLATION OF TEST PLUGS

A. Test Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.4 INSTALLATION OF FLOW-MEASURING ELEMENTS AND METERS

A. General: Install flow meters for piping systems located in accessible locations at most readable position.

B. Locations: Install flow measuring elements and meters as indicated.

C. Differential-Pressure-Type Flow Elements: Install minimum straight lengths of pipe upstream and downstream from element as prescribed by the manufacturer's installation instructions.

D. Install connections for attachment to portable flow meters in a readily accessible location.

E. Install connections, tubing, and accessories between flow elements and meters as prescribed by the manufacturer's installation instructions.

F. BTU Meters: Install in piping where indicated in hydronic supply line. Install thermal well in return line for remote sensor. Mount meter on wall if accessible; if not, provide bracket to support meter.

3.5 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

3.6 CONNECTIONS

A. Piping installation requirements are specified in other sections of Division 15. The drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install meters and gauges piping adjacent to equipment to allow servicing and maintaining of equipment.

3.7 MATERIAL TURNOVER

A. At conclusion of testing and balancing, turn over to Owner all portable flow meters required for any meter type installed.

3.1 COMMISSIONING

A. Refer to Section 01810 “Building System Commissioning” for additional requirements

END OF SECTION 15135

SECTION 15140 - SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Applicable Division 2 and 5 Specification Sections.

1.2 SUMMARY

A. This section includes the following:

1. Horizontal-piping hangers and supports.
2. Vertical-piping clamps.
3. Hanger-rod attachments.
4. Building attachments.
5. Saddles and shields.
6. Miscellaneous materials.
7. Pipe alignment guides.
8. Anchors.
9. Equipment supports.
10. Intermediate support steel (See Structural Drawings).

B. Related sections: The following sections contain requirements that relate to this section:

1. Division 15 Section "Basic Mechanical Materials and Methods" for materials for anchoring piping systems to building structure.
2. Division 15 Section "Basic Mechanical Materials and Methods" for field-applied painting requirements.
3. Division 15 Section "Vibration and Seismic Control" for vibration-isolation hangers and supports.
4. Division 15 Section "Mechanical Insulation" for pipe insulation.

1.3 DEFINITIONS

A. Terminology used in this section is defined in MSS SP-90.

1.4 BUILDING ATTACHMENTS

A. Concrete Frame Structures: In general attach all mechanical work to building structure utilizing either cast-in-place inserts or drilled-in-wedge expansion anchors. Submit for approval by structural engineer locations, loads and attachment details for all mechanical

work. All anchor materials to be used shall be as specified in specification sections pertaining to building structure and as approved by the Architect (powder actuated inserts shall not be used).

1. If cast-in-place inserts are proposed, provide building attachment submittal data with structural concrete reinforcement shop drawings.

1.5 SUBMITTALS

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Product data, including installation instructions for each type of support and anchor.

C. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.

D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.

E. Assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

1.6 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Qualify welding processes and welding operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

C. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.

D. NFPA Compliance: Hangers and supports shall comply with NFPA standard No. 13 when used as a component of a fire protection system.

E. UL and FM Compliance: Hangers, supports, and components shall be listed and labeled by UL and FM where used for fire protection piping systems.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
2. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
3. All hangers on insulated piping shall be oversized to be outside of the pipe insulation.

B. Thermal Hanger Shield Inserts: 100-psi average compressive strength, waterproofed calcium silicate, encased with a sheet metal shield. Insert and shield shall cover entire circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

C. Sliding Supports

1. Manufacturers:

a. Advanced Thermal Systems
b. Carpenter - Patterson
c. Grinnell

2. Model

a. Non-guided - Fig. 200 to 2-1/2 inch pipe, Fig. 301 for 3 inch and larger piping.
b. Guided - Fig. 100 to 2-1/2 inch pipe, Fig. 101 for 3 inch and larger pipe.

3. Features

a. Movement 8 inch axial and 6 inch total lateral movement (non-guided unit).
b. 1/2 inch graphite plates bonded to slide and base each with unit temperature range to 750 degrees F. Alternate Teflon pads with high temperature bond to 500 degrees F.

2.2 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be one part cement to three parts sand, by volume, with minimum amount of water required for placement and hydration.

C. Pipe Alignment Guides: Factory fabricated, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider

that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which supports and anchors are to be installed. Do not proceed with installing until unsatisfactory conditions have been corrected and all approvals from structural engineer have been obtained.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69 and SP-89. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

B. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.

C. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

D. Field-Fabricated, Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS D-1.1.

E. Support fire protection systems piping independently from other piping systems.

F. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

G. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

I. Insulated Piping: Comply with the following installation requirements, or install thermal hanger shield inserts per Part 2.

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
3. Shields: Install protective shields MSS Type 40 on insulated piping. Shields shall span an arc of 180 degrees and shall have dimensions in inches not less than the following:

NPS	LENGTH	THICKNESS
1/4 THROUGH 3-1/2	12	0.048
4	12	0.060
5 & 6	18	0.060
8 THROUGH 14	24	0.075
16 THROUGH 30	24	0.105

4. Pipes 1-1/2 inch and larger shall have a minimum of 180 degree arc of 100 psi average compressive strength calcium silicate inserts.
5. Insert material shall be at least as long as the protective shield.
6. Thermal Hanger Shields: Install where indicated, with insulation of same thickness as piping.

3.3 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs at intermediate points. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.4 EQUIPMENT SUPPORTS

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

B. Grouting: Place grout under supports for piping and equipment.

3.5 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made and methods used in correcting welding work.

D. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

1. Obtain fusion without undercut or overlap.
2. Remove welding flux immediately.
3. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.6 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2. mils.

C. For galvanized surfaces clean welds bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 15140

SECTION 15170 - MOTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes basic requirements for motors. It includes motors that are factory-installed as part of equipment and appliances as well as field-installed motors.

B. The requirements of the following Division 15 Sections apply to this Section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70, "National Electrical Code."

B. NRTL Listing: Provide NRTL listed motors.

1. Term "Listed": As defined in "National Electrical Code," Article 100.
2. Listing Agency Qualifications: "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

C. Comply with NEMA MG 1, "Motors and Generators."

D. Comply with UL 1004, "Motors, Electric."

PART 2 - PRODUCTS

2.1 MOTORS, GENERAL

A. General: Requirements below apply to motors covered by this Section except as otherwise indicated.

B. Motors 1/2 HP and Smaller: Single-Phase

C. Motors Larger Than 1/2 HP: Poly-phase.

D. Frequency Rating: 60 Hz.

E. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):

1. 120 V Circuit: 115 V - motor rating.

2. 208 V Circuit: 200 V - motor rating.
3. 240 V Circuit: 230 V - motor rating.
4. 277 V Circuit: 265 V - motor rating.
5. 480 V Circuit: 460 V - motor rating.

F. Service factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors which will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.

G. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100 percent of rated capacity.

H. Temperature Rise: Based on 40 deg C ambient except as otherwise indicated.

I. Enclosure: Open dripproof.

2.2 POLYPHASE MOTORS

A. General: Squirrel-cage induction-type conforming to the following requirements except as otherwise indicated.

B. NEMA Design Letter Designation: "B."

C. Service Factor: 1.15.

D. Multi-Speed Motors: Separate winding for each speed.

E. Efficiency

1. Motors which are 3-phase and 1 hp or larger (nonhermetic) must be NEMA design B and meet the following minimum levels of nominal efficiency. The motors must be tested in accordance with IEEE Standard 112 test method B and NEMA MG-1-12-53A.

2. Minimum Motor Efficiencies

OPEN DRIP-PROOF (ODP)			
	Speed (RPM)		
Motor	1200	1800	3600
Size (HP)	NEMA Nominal Efficiency		
1	82.5%	85.5%	77.0%
1.5	86.5%	86.5%	84.0%
2	87.5%	86.5%	85.5%
3	88.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	90.2%	91.0%	88.5%
10	91.7%	91.7%	89.5%

TOTALLY ENCLOSED FAN-COOLED (TEFC)			
	Speed (RPM)		
Motor	1200	1800	3600
Size (HP)	NEMA Nominal Efficiency		
1	82.5%	85.5%	77.0%
1.5	87.5%	86.5%	84.0%
2	88.5%	86.5%	85.5%
3	89.5%	89.5%	86.5%
5	89.5%	89.5%	88.5%
7.5	91.0%	91.7%	89.5%
10	91.0%	91.7%	90.2%

15	91.7%	93.0%	90.2%	15	91.7%	92.4%	91.0%
20	92.4%	93.0%	91.0%	20	91.7%	93.0%	91.0%
25	93.0%	93.6%	91.7%	25	93.0%	93.6%	91.7%
30	93.6%	94.1%	91.7%	30	93.0%	93.6%	91.7%
40	94.1%	94.1%	92.4%	40	94.1%	94.1%	92.4%
50	94.1%	94.5%	93.0%	50	94.1%	94.5%	93.0%
60	94.5%	95.0%	93.6%	60	94.5%	95.0%	93.6%
75	94.5%	95.0%	93.6%	75	94.5%	95.4%	93.6%
100	95.0%	95.4%	93.6%	100	95.0%	95.4%	94.1%
125	95.0%	95.4%	94.1%	125	95.0%	95.4%	95.0%
150	95.4%	95.8%	94.1%	150	95.8%	95.8%	95.0%
200	95.4%	95.8%	95.0%	200	95.8%	96.2%	95.4%

F. Variable Speed Motors: Provide inverter duty motors on all equipment connected to an variable frequency drive (VFD). Coordinate with variable speed drives specification, Section 15030.

1. Variable speed motors shall be of special high efficiency design, intended for variable load applications.
2. Motor shall be inverter duty and shall meet the requirements of NEMA MG-1 Part 31.40.4.2.
3. The motor shall be supplied in a cast-iron enclosure. Frame ratings shall be standard NEMA T frames by horsepower and speed.
4. The motor shall be rated for continuous duty, on adjustable frequency controller supplied power at 40 degree C ambient with a 1.0 service factor. The insulation shall be Class F, non-hygroscopic type, with Class B temperature rise.

G. Internal Thermal Overload Protection For Motors: For all motors, provide internal, automatic reset, thermostat which automatically opens power supply circuit to the motor. Protection operates when winding temperature exceeds safe value calibrated to the temperature rating of the motor insulation.

H. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading of the application.

I. Rugged Duty Motors: Totally enclosed. Provide motors with regreasable bearings and equipped with capped relief vents. Insulate windings with nonhygroscopic material. External finish shall be chemical resistant paint over corrosion resistant primer. Provide integral condensate drains.

J. Motors for Reduced Inrush Starting: Coordinate with indicated reduced inrush controller type and with characteristics of driven equipment load. Provide required wiring leads in motor terminal box to suit control method.

K. Unless provided with a VFD all motors 5 hp and over shall have power factor correction

devices mounted at the motor wiring terminals to correct the power factor to between 0.95 and 0.99 at full load.

2.3 SINGLE-PHASE MOTORS

A. General: Conform to the following requirements except as otherwise indicated.

B. Energy Efficient Motors: One of the following types as selected to suit the starting torque and other requirements of the specific motor application.

1. Permanent Split Capacitor.
2. Split-Phase Start, Capacitor-Run.
3. Capacitor-Start, Capacitor-Run.

C. Internal Thermal Overload Protection for Motors: For all motors, provide internal, automatic reset, thermostat which automatically opens the power supply circuit to the motor. Protection operates when winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation.

D. Bearings, belt connected motors and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single phase motors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: The following requirements apply to field-installed motors.

B. Install motors in accordance with manufacturer's published instructions and the following:

1. Direct Connected Motors: Mount securely in accurate alignment.
2. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

C. COMMISSIONING

1. Check operating motors, both factory and field-installed, for unusual conditions during normal operation. Coordinate with the commissioning of the equipment for which the motor is a part.
2. Report unusual conditions.
3. Correct deficiencies of field-installed units.

END OF SECTION 15170

SECTION 15190 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. This section is complementary to Division 15 Basic Mechanical Materials and Methods section, and is part of each Division 15 section making reference to identification devices specified herein.

1.2 SUMMARY

A. Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other Division 15 sections.

B. Provide identification for all equipment and systems provided by this contract.

C. Types of identification devices specified in this section include the following:

1. Painted Identification Materials.
2. Plastic Pipe Markers.
3. Underground-Type Plastic Line Marker.
4. Valve Tags.
5. Valve Schedule Holders
6. Equipment Nameplates

D. Related Sections: The following sections contain requirements that relate to this Section:

1. Other Division 15 sections for mechanical identification furnished as part of factory-fabricated equipment assembly.

1.3 SUBMITTALS

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2 inch x 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies,

furnish extra copies for Maintenance Manuals as specified in Division 1.

1.4 QUALITY ASSURANCE

A. Codes and Standards:

1. ANSI Standards: Comply with (ASME) ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following:

1. Marking Services Incorporated.
2. Brady (W.H.) Co.; Signmark Div.
3. Industrial Safety Supply Co., Inc.
4. Seton Name Plate Corp.

2.2 MECHANICAL IDENTIFICATION MATERIALS

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 15 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.3 PAINTED IDENTIFICATION MATERIALS

A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI (ASME) A13.1 for piping and similar applications, but not less than 1-1/4 inch high letters.

B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

2.4 PLASTIC PIPE MARKERS

A. Pressure-Sensitive Type: Provide manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI (ASME) A13.1.

B. Small Pipes: For external diameters less than 6 inch (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Adhesive lap joint in pipe marker overlap.
2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inch. Tape to include arrows to indicate direction of flow.

C. Large Pipes: For external diameters of 6 inch and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inch wide; full circle at both ends of pipe marker, tape lapped 3 inch. Tape to include arrows to indicate direction of flow.
2. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

D. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.

E. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.5 UNDERGROUND-TYPE PLASTIC LINE MARKERS

A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6 inch wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.

1. Provide multiply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.6 VALVE TAGS

A. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately 3/16 inch high letters and sequenced valve numbers approximately 3/8 inch high, and with 5/32 inch hole for fastener.

1. Provide 1-1/8 inch sq. white tags with black lettering.

B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.7 VALVE SCHEDULE HOLDERS

A. General: For each page of valve schedule, provide flexible plastic envelopes with reinforced three-ring punchings.

2.8 EQUIPMENT NAMEPLATES

A. Black phenolic nameplate, 1/16 inch minimum thick, with 1/2 inch high engraved white letter. Minimum size shall be 2-1/2 inch long and 1 inch high. Secure with two sheet metal screws.

2.9 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
2. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.

B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

1. Near each valve and control device.

2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 25 feet along each piping run.

3.3 UNDERGROUND PIPING IDENTIFICATION

A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6 inch to 8 inch below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16 inch, install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.4 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves and valves within factory-fabricated equipment units. List each tagged valve in valve schedule for each piping system.

3.5 MECHANICAL EQUIPMENT IDENTIFICATION

A. General: Install nameplates or stenciled marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment:

1. Pumps and similar motor-driven units.
2. Heat exchangers, cooling towers and similar equipment.
3. Fans.

3.6 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices.

3.7 COMMISSIONING

A. Refer to Section 01810 “Building System Commissioning” for additional requirements.

END OF SECTION 15190

SECTION 15241 - VIBRATION AND SEISMIC CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

A. Extent of vibration control work required by this section is indicated on drawings and schedules, and/or specified in other Division 15 sections.

B. Provide vibration isolation for all equipment and piping within the chiller room. All vibration isolation systems within the chiller room shall be selected for a minimum deflection of 1 inch.

C. Types of vibration control products specified in this section include the following:

1. Fiberglass Pads and Shapes.
2. Neoprene Pads.
3. Neoprene Mountings - Code A.
4. Spring Isolators, Free-Standing - Code B.
5. Spring Isolators, Vertically-Restrained - Code C.
6. Spring Isolation Hangers - Code D.
7. Neoprene Isolation Hangers - Code D1.
8. Precompressed Spring Hangers - Code E.
9. Fabricated Equipment Bases - Code G.
10. Equipment Rails - Code H.
11. Inertia Base - Code J.
12. Flexible Pipe Connectors - Code L.
13. Flexible Pipe Connectors - Code K.
14. Acoustical Pipe Seal - Code M.
15. All-Directional Anchors - Code N.
16. Riser Isolators.
17. Thrust Restraints - Code R.
18. Spring Isolators, Earthquake-Restrained - Code W.
19. Seismic Snubbers - Code Z.
20. Housekeeping Pad Anchors.

D. Related Sections: Refer to other Division 15 Sections for requirements that relate to this Section such as the following:

1. Vibration control products furnished as integral part of factory-fabricated equipment assembly.
2. Equipment foundations, hangers, sealants, gaskets, and other work related to vibration control work.
3. Requirements of electrical connections to equipment isolated on vibration control products.

1.3 SUBMITTALS

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. For seismic control submittals, provide all applicable engineering calculations, bearing the stamp and seal of a registered engineer in the state which the project is constructed.

1.4 QUALITY ASSURANCE

A. Except as otherwise indicated, obtain vibration control products from single manufacturer.

B. Engage manufacturer to provide technical supervision of installation of vibration control products.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide vibration control products of one of the following:

1. Mason Industries, Inc.
2. Amber/Booth Co.
3. Kinetics
4. Vibration Eliminator Co., Inc.
5. Vibration Mountings and Controls, Inc.

2.2 VIBRATION CONTROL MATERIALS AND SUPPORT UNITS

A. Fiberglass Pads and Shapes: Glass fiber of not more than 0.18 mil diameter, produced by multiple-flame attenuation process, molded with manufacturer's standard fillers and binders through 10 compression cycles at 3 times rated load bearing capacity, to achieve natural frequency of not more than 12 Hertz, in thicknesses and shapes required for use in vibration isolation units.

B. Neoprene Pads: Oil-resistant neoprene sheets, of manufacturer's standard hardness and

cross-ribbed or waffled pattern.

C. Neoprene Mountings (Code A): Provide neoprene mountings consisting of neoprene element bonded between 2 steel plates that are neoprene-covered to prevent corrosion. Provide minimum rated deflection of 0.35 inch. Provide threaded hole in upper plate and 2 holes in base plate for securing to equipment and to substrate equal to Mason Industries, Type N or ND.

D. Spring Isolators, Free-Standing (Code B): Except as otherwise indicated, provide vibration isolation spring between top and bottom loading plates, and with pad-type isolator bonded to bottom of bottom loading plate. Include studs or cups to ensure centering of spring on plates. Include leveling bolt with lock nuts and washers, centered in top plate, arranged for leveling and anchoring supported equipment as indicated equal to Mason Industries Type SLFH.

1. Include holes in bottom plate for bolting unit to substrate.

E. Spring Isolators, Vertically-Restrained (Code C): Provide spring isolators in housing that includes vertical limit stops. Design housing to act as blocking during erection, and with installed height and operating height being equal. Maintain 1/2 inch minimum clearance around restraining bolts, and between housing and springs. Design so limit stops are out of contact during normal operation equal to Mason Industries Type SLR.

1. Isolators exposed to weather shall be hot dipped galvanized.

F. Spring Isolation Hangers (Code D): Hanger units formed with brackets and including a steel spring and 0.3 inch deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection, equal to Mason Industries Type 30N.

G. Neoprene Isolation Hangers (Code D1): Hanger units formed with brackets and including manufacturer's standard compression rubber isolation. Design brackets for 3 times rated loading of units. Fabricate units to accept misalignment of 15 deg. off center in any direction before contacting hanger box, and for use with either rod or strap type members, and including acoustical washers to prevent metal-to-metal contacts equal to Mason Industries Type HD or WHD.

1. Provide neoprene element with deflection range of 0.2 to 0.5 inch, securely retained in hanger box and color coded for weight range.

H. Precompressed Spring Hangers (Code E): Vibration hangers shall be as described in Code D but they shall be precompressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is

subjected to its full load. Deflection shall be clearly indicated by means of a scale. Hangers shall be type PC30N.

I. Inertia Base (Code J:) Features shall be as for Code G bases except where inertia bases are indicated for use with isolation units to support equipment, provide rectangular structural beam channel, or complete sheet metal box concrete forms for floating foundations, with materials, complying with ASTM A36. Frame unit with minimum depth of 0.08 x longest dimension of base, but not less than 6 inch deep. Size frame so that weight of frame plus concrete fill will be greater than operating weight of equipment supported. Provide steel reinforcing both ways with both ends of reinforcing butt welded to base frame, equal to Mason Industries Type K.

J. Flexible Pipe Connectors (Code L):

1. For non-ferrous piping, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, braze-welded to hose.
2. For ferrous piping, provide stainless steel hose covered with stainless steel wire braid with NPT steel nipples or 150 psi ANSI flanges, welded to hose.

K. All-Directional Anchors (Code N): Provide all-directional acoustical pipe anchor consisting of telescopic arrangement of 2 sizes of steel tubing separated by minimum 1/2 inch thickness of heavy-duty neoprene and duck, or neoprene isolation material. Provide vertical restraints by similar material arranged to prevent vertical travel in either direction. Design for maximum 500 psi load on isolation materials, and provide for equal resistance in any direction. Equip anchor with threaded hole on top and 2 holes in base plate for bolting down; or provide welding provisions top and bottom, if indicated, equal to Mason Industries Type ADA.

L. Spring Isolators, Earthquake-Restrained (Code W): Provide spring isolator assembly which will resist horizontal and vertical forces in accordance with applicable regional seismic codes.

M. Seismic Snubbers (Code Z): Provide seismic snubbers, separate from spring isolators, for attachment to equipment base, designed to provide seismic restraint in all modes in accordance with applicable regional seismic codes. Provide snubbers designed to have no contact during normal operation, and have minimum clearances of 1/4 inch in all directions. The snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications per ASTM D-676, ASTM D-412, ASTM D-573, ASTM D-1149 and ASTM D-395.

1. Elastomeric materials shall be replaceable and a minimum of 3/4" thick. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" nor more than 1/4". Snubbers shall be installed with factory set clearances.
2. The capacity of the seismic snubber at 3/8" deflection shall be 3 to 4 times the load

assigned to the mount grouping in its immediate area. Submittals shall include load deflection curves up to 1/2" deflection in the x, y and z planes. Tests shall be conducted in an independent laboratory or under the signed supervision of an independent registered engineer. The snubber assemblies shall be bolted to the test machine as the snubber is normally installed. Test reports shall certify that neither the neoprene elements nor the snubber body sustained any obvious deformation after release of load. Snubbers shall be equal to series Z-1011 as manufactured by Mason Industries, Inc. or approved equal.

N. Housekeeping pad anchors: Shall consist of a ductile iron casting that is tapered and hexagonal, smaller at its base that at its top. The upper portion shall have holes for rebar to pass through. The anchor shall be continuously threaded from top to bottom for the attachment of soleplates. Housekeeping pad anchors shall be attached to the structural slab using a stud wedge anchor. Housekeeping pad anchors shall be type HPA and stud wedge anchor shall be type SAS both as manufactured by Mason Industries, Inc.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which vibration and seismic control units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PERFORMANCE OF ISOLATORS

A. General: Comply with minimum static deflections recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.3 APPLICATIONS

A. General: Supply vibration isolation products as scheduled on drawings and installed in accordance with ASHRAE Handbook, 1999 HVAC Applications Volume, Chapter 46 "Sound and Vibration Control", and Chapter 53 “Seismic and Wind Restraint Design”.

B. Piping:

1. All chilled water, and indoor condenser water piping that is connected to vibration-isolated equipment shall be isolated from the building structure within the following limits:

a. Within the chiller room.

2. Piping shall be isolated from the building structure by means of vibration isolation mounts, resilient pipe guides, and resilient penetration sleeve/seals.
3. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment. When the required static deflection of these isolators is greater than 1/2", Code B or Code E isolators shall be used. When the required static deflection is less than or equal to 1/2", Type Code A or Code D1 isolators shall be used. All other pipe support isolators within the specified limits shall be either Code A, D or D1 achieving 0.25" static deflection.
4. For piping connected to equipment hanging from structure under occupied spaces, the first three hangers shall have 0.75 inch deflection for pipe sizes up to and including 3 inches, 1.5 inch deflection for pipe sizes up to and including 6 inches and 2.5 inch deflection thereafter. All other hangers and mounts shall have a minimum steel spring deflection of 0.75 inches. Hangers shall be located as close to the overhead supports as practical.
5. Where lateral support of pipe risers is required within the specified limits, this shall be accomplished by use of resilient lateral supports.
6. Pipes within the specified limits that penetrate the building construction shall be isolated from the building structure by use of Code M pipe seal.
7. Provide flexible pipe connections at all equipment mounted on vibration control products and wherever shown on the drawings.
8. Risers shall be suspended from or supported by Code E hangers or Code C mountings and the piping anchored or guided with Code N anchors. Steel spring deflections shall be a minimum of 0.75 inches except in those expansion locations where additional deflection is required to limit deflection or load changes to plus or minus 25% of the initial stress.

3.4 INSTALLATION

A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.

B. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

D. Install inertia base frames on isolator units as indicated, so that minimum of 1 inch clearance below base will result when frame is filled with concrete and supported

equipment has been installed and loaded for operation. Provide concrete for inertia bases.

E. Locate isolation hangers as near overhead support structure as possible.

F. Weld riser isolator units in place as required to prevent displacement from loading and operations.

G. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

3.5 SEISMIC RESTRAINT AND BRACING

A. Seismic Restraints for Equipment:

1. Floor or pad mounted equipment, without vibration isolators, shall be bolted to the floor or other support.
2. Floor mounted equipment, with vibration isolators shall be provided with lateral and vertical restraining devices on all sides of the base to restrict displacement of the equipment.
3. On all sides of suspended equipment, provide bracing for rigid supports and provide restraints for resiliently supported equipment.
4. Snubbers: Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure.
5. All housekeeping pads shall be installed with housekeeping pad anchors.
6. Restraints shall be capable of withstanding horizontal earthquake forces of 0.25, , 0.35 equipment weight in any direction.

B. Seismic Bracing of Piping

1. Provide seismic restraint for piping in accordance with SMACNA Seismic Restraint Manual - Guidelines for Mechanical Systems", 1998 Edition, and ASHRAE Handbook 1999 Applications Volume, Chapter 53 “Seismic and Wind Restraint Design”.
   a. In general piping restraint shall be designed to meet or exceed requirements for seismic hazard level (SHL) A, B, C.
   b. Water Piping:
      (1) Provide bracing for water pipes 2-1/2 inch diameter and larger. Brace fuel gas pipe 1-inch diameter and larger.
      (2) Omit seismic restraints for piping suspended by individual hangers 12 inches or less in length from the top of pipe to the bottom of the support for the hanger.
      (3) Fastening a rigid piping system to two dissimilar parts of the building that may respond differently, such as a wall and ceiling is prohibited.

(4) Transverse brace supports shall be at 40 feet on center, maximum.
(5) Longitudinal brace supports shall be at 80 feet on centers, maximum.

c. Transverse bracing for one pipe section may act as longitudinal bracing for the pipe section connected perpendicular to it, provided the bracing is installed within 24 inches of the elbow or tee and pipes are within one pipe size.
d. Do not use branch lines to brace main lines.
e. Where a lateral brace is required at the same location as a vertical hanger, the vertical hanger may be omitted.
f. Support the weight of the rise above the riser center of gravity per floor or at 30 feet on centers in pipe chases.

C. Pipe Expansion - Seismic

1. Mains
a. Ball joints or slide joints at each cross over between new and existing construction to match building deflection at that floor.

3.6 ADJUSTING AND CLEANING

A. Upon completion of vibration and seismic control work, prepare report showing measured equipment deflections for each major item of equipment as indicated.

B. Clean each control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

END OF SECTION 15241

SECTION 15250 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of mechanical insulation specified in this section include the following:

1. Piping System Insulation:

a. Fiberglass
b. Cellular Glass
c. Calcium Silicate
d. Flexible Unicellular

2. Equipment Insulation:

a. Fiberglass.

C. Related Sections: The following Sections contain requirements that relate to this Section.

1. Division 15 section "Supports and Anchors" for protection saddles, protection shields, and thermal hanger shields; not work of this section.
2. Division 15 section "Mechanical Identification" for installation of identification devices for piping, ductwork, and equipment; not work of this section.

1.3 SUBMITTALS

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.4 QUALITY ASSURANCE

A. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.

B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastic and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

C. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

1. ArmaCell
2. Babcock & Wilcox; Insulating Products Div.
3. CertainTeed Manson.
4. Knauf Fiber Glass GmbH.
5. Johns Manville
6. Owens-Corning Fiberglass Corp.
7. Pittsburgh Corning Corp.
8. Rubatex Corp.

2.2 PIPING INSULATION MATERIALS

A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated.

B. Calcium Silicate Piping Insulation: ASTM C 533, Type I.

C. Cellular Glass Piping Insulation: ASTM C 552, Type II, Class 2.

D. Flexible Unicellular Piping Insulation: ASTM C 534, Type I.

E. Jackets for Piping Insulation: ASTM C 1136, Type I for piping with temperatures below

ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.

1. Encase fiberglass and calcium silicate pipe fittings insulation with one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.
2. Encase all exposed pipe insulation in occupied rooms with PVC pipe covers.

    a. Thickness shall be 30 mil from floor level to 9 feet above finished floor. Otherwise, thickness shall be 20 mil.
    b. Bond all PVC seams in occupied rooms with polyco VP adhesive, or equal. Bond adhesive shall conform to ASTM D-2654.

3. Encase exterior piping insulation with aluminum jacket with weather-proof construction.

F. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

G. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

H. Removable/Reusable Insulation Valve Covers: Two piece, silicone impregnated finish, Type E glass fiber insulation. Multiglas Products Co., MULTI COV-R, or approved equal.

2.3 EQUIPMENT INSULATION MATERIALS

A. Rigid Fiberglass Equipment Insulation: ASTM C 612, Class 2, 6 LBS/FT3.

B. Jacketing Material for Equipment Insulation: Provide aluminum jacket.

C. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastic and protective finishes as recommended by insulation manufacturer for applications indicated.

D. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PLUMBING PIPING SYSTEM INSULATION

A. Insulation Omitted: Omit insulation on drainage piping and buried domestic cold water piping.

B. Cold Piping Application Requirements: Insulate the following cold plumbing piping systems:

1. Interior above-ground domestic cold water piping.

2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 1/2 inch thickness, for pipe up to 1 inch; 1 inch thickness for pipe over 1 inch.

3.3 HVAC PIPING SYSTEM INSULATION

A. Insulation Omitted: Omit insulation on condenser water piping without heat trace.

B. Cold Piping (40 degree F to ambient) Application Requirements: Insulate the following cold HVAC piping systems:

1. HVAC chilled water supply and return piping.
2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 1 inch thick for pipe sizes up to and including 1 inch, 1-1/2 inch thick for 1-1/4 inch and larger. Provide vapor barrier.

C. Outdoor Piping (to 250 deg. F) Application Requirements: Insulate the following piping systems.

1. Condenser water supply and return piping which are provided with heat trace.

2. Insulate each piping system specified above the following type and thickness of insulation:

a. Cellular Glass: 2 inch thickness with "Pittcote 300" coating and outdoor insulation aluminum jacket.

3.4 EQUIPMENT INSULATION

A. Cold Equipment (Below Ambient Temperature) Application Requirements: Insulate the following cold equipment:

1. Chilled water pumps.
2. Insulate each item of equipment specified above with one of the following types

and thicknesses of insulation:

a. Rigid Fiberglass: 1-1/2 inch thick.

3.5 INSTALLATION OF PIPING INSULATION

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

F. Cover valves, fittings and all other piping system components in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3 inch wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 inch wide vapor barrier tape or band.

I. Provide removable valve covers for valves which must be accessed periodically.

3.6 INSTALLATION OF EQUIPMENT INSULATION

A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and

excessive voids resulting from poor workmanship.

C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

D. Apply insulation using staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.

E. Coat insulated surfaces with layer of insulating cement, trawled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

F. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2 inch. Apply over vapor barrier where applicable.

G. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, accessories and pumps.

3.7 OUTDOOR INSULATION FINISH

A. General: Piping and equipment exposed to weather shall have insulation protective jacketing installed as recommended by manufacturer.

B. Piping: Shall have aluminum jacket with moisture barrier with locking longitudinal seam and butt straps. Fittings, valves, flanges, etc. shall have factory or job fabricated aluminum cover secured with banding and/or screws.

3.8 EXISTING INSULATION REPAIR

A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.9 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 15250

SECTION 15411 - WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."
3. "Basic Piping Materials and Methods."
4. "Supports and Anchors."

1.2 SUMMARY

A. This Section includes domestic cold water piping, fittings, and specialties within the building and underground.

B. Related Sections: The following Sections contain requirements that relate to this section.

1. Division 15 Section "Basic Mechanical Materials and Methods" for materials and methods for sealing pipe penetrations through basement walls and fire and smoke barriers.
2. Division 15 Section "Valves."
3. Division 15 Section "Meters and Gauges" for thermometers and pressure gauges.
4. Division 15 Section "Mechanical Identification" for labeling and identification of piping system.
5. Division 15 Section "Vibration and Seismic Control" for piping seismic support.

1.3 DEFINITIONS

A. Water Distribution Pipe: A pipe within the building or on the premises that conveys water from the water service pipe or meter to the points of usage.

B. Water Service Pipe: The pipe from the water main or other source of water supply to the water distributing system of the building served.

C. Pipe sizes used in this Specification are nominal pipe size (NPS).

1.4 SUBMITTALS

A. Refer to Section 15010 “Basic Mechanical Requirements”.

B. Product data for each piping specialty and valve specified.

C. Certification of Compliance with ASME and UL fabrication requirements specified below.

D. Test reports specified in Part 3 of this Section.

E. Maintenance data for each piping specialty and valve specified for inclusion in Maintenance Manual specified in Division 1 and Division 15 Section - "Basic Mechanical Requirements."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15010 “Basic Mechanical Requirments”.

B. Store pipe in a manner to prevent sagging and bending.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate the installation of pipe sleeves for foundation wall penetrations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hose Bibbs:

a. Lee Brass Co.
b. Mansfield Plumbing Products.
c. Nibco, Inc.
d. Watts Regulator Co.
e. Woodford Mfg. Co.

2. Vacuum Breakers For Hose Connections:

a. Cash (A.W.) Valve Mfg. Corp.
b. Conbraco Industries, Inc.
c. Watts Regulator Co.

2.2 PIPE AND TUBE MATERIALS, GENERAL

A. Pipe and Tube: Refer to Part 3, Article "Application, General", for identification of systems where the below materials are used.

B. Copper Tube: ASTM B 88, Type L Water Tube, drawn temper.

C. Copper Tube: ASTM B 88, Type K Water Tube, annealed temper.

D. Ductile-Iron Pipe: AWWA C151 or AWWA C115 ductile-iron pipe, with AWWA C104 cement-mortar lining.

2.3 FITTINGS

A. Wrought Copper Solder-Joint Fittings: ANSI B16.22, streamlined pattern.

B. Ductile-Iron Gasketed Fittings: AWWA C110 or AWWA C153, 150 psi rating, with cement mortar lining and AWWA C111 rubber gaskets.

2.4 JOINING MATERIALS

A. Solder Filler Metal: ASTM B 32, 95-5 Tin-Antimony.

B. Brazing Filler Metals: AWS A5.8, BCuP Series.

C. Gasket Material: Thickness, material, and type suitable for fluid to be handled and design temperatures and pressures.

2.5 GENERAL-DUTY VALVES

A. General-duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 15 Section "Valves". Special duty valves are specified below by their generic name; refer to Part 3 Article "Valve Application" for specific uses and applications for each valve specified.

2.6 PIPING SPECIALTIES

A. Hose Connections: Hose connections shall have garden hose thread outlets conforming to ASME B1.20.7.

B. Hose Bibbs: Bronze body, renewable composition disc, tee handle, 1/2- or 3/4 inch solder inlet, hose outlet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in requirements for equipment with water connections to verify actual locations of piping connections prior to installation.

3.2 PIPE APPLICATIONS

A. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes 4 inch and smaller, above ground, within building. Install Type K, annealed temper copper tube for pipe sizes 2 inch and smaller, with minimum number of joints, below ground.

B. Install cement-lined ductile-iron pipe with rubber gasketed joints below ground, inside and outside building.

3.3 PIPING INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and branch connections.

C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.

I. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls with mechanical seals.

J. Install piping level with no pitch.

K. Brace Piping for seismic control per Division 15 Section, "Vibration and Seismic Control"

and details on drawings.

3.4 HANGERS AND SUPPORTS

A. General: Hanger, support, and anchor devices conforming to MSS SP-69 are specified in Division 15 Section "Supports and Anchors." Conform to the table below for maximum spacing of supports:

B. Pipe Attachments: Install the following:

1. Adjustable steel clevis hangers, MSS Type 1, for individual horizontal runs less than 20 feet in length.
2. Install hangers for horizontal piping with the following maximum spacing and minimum rod sizes:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 3/4		5	3/8
1		6	3/8
1-1/4		7	3/8
1-1/2		8	3/8
2		8	3/8
2-1/2		9	1/2
3		10	1/2
3-1/2		11	1/2
4	15	12	5/8 (1/2 for copper)

C. Support vertical steel pipe and copper tube at each floor.

3.5 PIPE AND TUBE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."

B. Joints in domestic water piping shall be properly fluxed and assembled with solders and fluxes with a lead content not greater than 0.2 percent (2/10 of 1 percent). Lead-based solders and fluxes are prohibited from use for joint assembly or backup.

C. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before brazing.
2. Heat joints to proper and uniform temperature.

D. Threaded Joints: Conform to ASME B1.20.1, tapered pipe threads for field-cut threads.

Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
2. Align threads at point of assembly.
3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

    a. Damaged Threads: Do not use pipe with corroded or damaged threads. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

E. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.6 VALVE APPLICATIONS

A. General-Duty Valve Applications: Where specific valve types are not indicated, the following requirements apply:

1. Shut-off duty: Use gate, ball, and butterfly valves.

3.7 INSTALLATION OF VALVES

A. Sectional Valves: Install sectional valves on each branch and riser, close to main, and elsewhere as indicated. For sectional valves 2 inch and smaller, use gate or ball valves; for sectional valves 2-1/2 inch and larger, use gate or butterfly valves.

B. Shutoff Valves: Install shutoff valves as indicated. For shutoff valves 2 inch and smaller, use gate or ball valves; for shutoff valves 2-1/2 inch and larger, use gate or butterfly valves.

C. Drain Valves: Install drain valves at low points of horizontal runs, and elsewhere as required to drain distribution piping system completely. For small drains use 3/4 inch hose end drain valves.

D. Hose Bibbs: Install on exposed piping where indicated with vacuum breaker.

3.8 FIELD QUALITY CONTROL

A. Inspections: Inspect water distribution piping as follows:

1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.

2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

    a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed in after system is roughed in and prior to setting fixtures.
    b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
3. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
4. Reports: Prepare inspection reports signed by the plumbing official.

B. Test water distribution piping as follows:

1. Test for leaks and defects all new water distribution piping systems and parts of existing systems that have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
3. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
4. Repair all leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
5. Prepare reports for all tests and required corrective action.

3.9 ADJUSTING AND CLEANING

A. Clean and disinfect water distribution piping as follows:

1. Purge all new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired prior to use.
2. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:

    a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.
    b. Fill the system or part thereof with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system or part

thereof and allow to stand for 24 hours.

c. Drain the system or part thereof of the previous solution and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.

3. Following the allowed standing time, flush the system with clean, potable water until chlorine does not remain in the water coming from the system.
4. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.
5. Prepare reports for all purging and disinfecting activities.

3.10 COMMISSIONING

A. Before operating the system, perform these steps:

1. Close drain valve, hydrants, and hose bibbs.
2. Open valves to full open position.
3. Fill the system.

END OF SECTION 15411

SECTION 15420 - DRAINAGE AND VENT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."
3. "Supports and Anchors."

1.2 SUMMARY

A. This Section includes building sanitary and storm drainage and vent piping systems, including drains and drainage specialties.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 15 Section "Basic Mechanical Materials and Methods" for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.

1.3 DEFINITIONS

A. Drainage System: Includes all the piping within a public or private premises which conveys sewage, rain water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following:

1. International Plumbing Code.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate the installation of drains in poured-in-place concrete slabs, to include proper drain elevations, installation of flashing, and slope of slab to drains.

B. Coordinate with installation of sanitary and storm sewer systems as necessary to interface building drains with drainage piping systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide drainage and vent systems from one of the following:

1. Drainage Piping Specialties, drains:

a. Ancon Inc.
b. Josam Mfg. Co.
c. Smith (Jay R) Mfg. Co.
d. Wade Division/Tyler Pipe: Subs. of Tyler Corp.
e. Zurn Industries Inc; Hydromechanics Div.

2.2 UNDERGROUND BUILDING DRAIN PIPE AND FITTINGS

A. Cast iron soil pipe, service weight, hub and spigot and fittings. ASTM A74.

1. Rubber and neoprene compression gaskets. ASTM C564.

2. Pipe and fittings shall have a heavy coating of coal tar varnish or asphaltum on both inside and outside surfaces.

2.3 DRAINAGE PIPING SPECIALTIES

A. Cleanout Plugs: Cast-bronze or brass, threads complying with ANSI B2.1, countersunk head.

B. Floor Cleanouts: Cast-iron body and frame with cleanout plug and adjustable round top.

C. Flashing Flanges: Cast-iron watertight stack or wall sleeve with membrane flashing ring. Provide underdeck clamp and sleeve length as required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION FOUNDATION FOR UNDERGROUND BUILDING DRAINS

A. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.

B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated invert elevation.

C. Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand backfill. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation.

3.3 PIPE AND TUBE JOINT CONSTRUCTION

A. Cast-Iron Soil Pipe: Make lead and oakum caulked joints, compression joints, and hubless joints in accordance with the recommendations in the CISPI Cast Iron Soil Pipe and Fittings Handbook, Chapter IV.

3.4 INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into account many design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited

D. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

E. Install building drain pitched down at minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger.

F. Extend building drain to connect to sewer piping, of size and in location indicated.

G. Install sleeve and mechanical sleeve seal at above floor penetrations through foundation wall for watertight installation.

H. Brace Piping for seismic control per Division 15 Section "Vibration and Seismic Control".

3.5 HANGERS AND SUPPORTS

A. General: Hanger, supports, and anchors devices are specified in Division 15 Section "Supports and Anchors". Conform to the table below for maximum spacing of supports:

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs.

C. Install hangers at the following intervals:

PIPE MATERIAL	MAX HORIZ. SPACING IN FEET	MAX VERT SPACING IN FEET
Cast-Iron Pipe	5	15
Copper Tubing - 1-1/4 inch and larger	6	10
Copper Tubing - 1-1/2 inch and larger	10	10

3.6 INSTALLATION OF FLOOR DRAINS

A. Install floor drains in accordance with manufacturer's written instructions and in locations indicated.

B. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.

C. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

D. Position drains so that they are accessible and easy to maintain.

3.7 FIELD QUALITY CONTROL

A. Inspections

1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting

fixtures.

b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

3. Reinspection: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.
4. Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test: Test drainage and vent system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.

3.8 ADJUSTING AND CLEANING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

B. Clean drain domes and traps. Remove dirt and debris.

3.9 PROTECTION

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION 15420

SECTION 15510 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

B. The following Division 15 Sections apply to this Section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."
3. "Valves."
4. "Supports and Anchors."

1.2 SUMMARY

A. This Section includes piping systems for chilled water cooling, condenser water, make-up water for these systems, blow-down drain lines, and condensate drain piping. Piping materials and equipment specified in this Section include:

1. Pipes, fittings, and specialties;
2. Special duty valves;
3. Hydronic specialties.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 15 Section "Basic Mechanical Materials and Methods" for sealing pipe penetrations through basement walls and fire and smoke barriers.
2. Division 15 Section “Basic Piping Materials and Methods” for Y-pattern strainers and basket strainers.
3. Division 15 Section "Valves" for gate, globe, ball, butterfly and check valves.
4. Division 15 Section "Meters and Gauges" for thermometers, flow meters, and pressure gauges.
5. Division 15 Section "Vibration and Seismic Control" for piping seismic support, and flexible connections.
6. Division 15 Section "Mechanical Identification" for labeling and identification of hydronic piping system.
7. Division 15 Section "Mechanical Insulation" for pipe insulation.
8. Division 15 Section "HVAC Pumps" for pumps, motors and accessories for hydronic systems.
9. Division 15 Section "Controls" for temperature control valves and sensors.
10. Division 15 Section "Testing, Adjusting and Balancing" for procedures for hydronic systems adjusting and balancing.

1.3 DEFINITIONS

A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

1.4 SUBMITTALS

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Furnish flow and pressure drop curves for diverting fittings and calibrated plug valves, based on manufacturer's testing.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following:

1. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
2. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
3. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are shown in structural drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide hydronic piping system products from one of the following:

1. Balancing Valves, up to 3 inch:

a. Bell & Gossett; Circuit Setter.
b. Taco, Inc., ACCU-Flo.

2. Combination Balancing and Shutoff Valves, up to 12 inch:

a. Armstrong, Model CBV
b. Tour and Anderson, STA series
c. Bell & Gossett; Circuit Setter

3. Pump Discharge Valves:

a. Armstrong Pumps, Inc.

b. Bell & Gossett ITT
c. Taco, Inc.
d. Thrush Company, Inc.

4. Safety Relief Valves:

a. Bell & Gossett ITT
b. Spirax Sarco.
c. Watts Regulator Co.
d. Thrush Company, Inc.

5. Air Vents (manual and automatic):

a. Armstrong Machine Works.
b. Bell & Gossett ITT
c. Hoffman Specialty ITT
d. Spirax Sarco.

6. Pump Suction Diffusers:

a. Armstrong Pumps, Inc.
b. Bell & Gossett ITT
c. Taco, Inc.
d. Thrush Company, Inc.
e. Victaulic Company of America

7. Diverting Fittings:

a. Armstrong Pumps, Inc.
b. Bell & Gossett ITT
c. Taco, Inc.
d. Thrush Company, Inc.

8. Automatic Flow Control Valves

a. Autoflow Inc.
b. Griswold Controls.

9. Thermostatic Control Valves (Non-electric)

a. Bell & Gossett ITT
b. Danfoss
c. Honeywell Braukman
d. Taco, Inc.

2.2 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3 Article "PIPE APPLICATIONS" for identification of where the below materials are used.

B. Drawn Temper Copper Tubing: ASTM B 88, Type L.

C. Annealed Temper Copper Tubing: ASTM B 88, Type K.

D. Steel Pipe: ASTM A 53, Schedule 40, black steel pipe, plain ends.

2.3 FITTINGS

A. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

B. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

C. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.

D. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.

E. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125; raised ground face, bolt holes spot faced.

F. Cast Bronze Flanges: ANSI B16.24, Class 150; raised ground face, bolt holes spot faced.

G. Steel Flanges and Flanges Fittings: ANSI B16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:

1. Material Group: 1.1.
2. End Connections: Butt Welding.
3. Facings: Raised face.

H. Unions: ANSI B16.39 malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.

2.4 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, 50-50, Tin-Lead, for condenser water, chilled water and drain piping.

B. Solder Filler Metals: ASTM B 32, 95-5, Tin-Antimony, for heating hot water, dual temperature water and glycol solution piping.

C. Brazing Filler Metals: AWS A5.8, Classification Bag 1 (Silver).

1. WARNING: Some filler metals contain compounds which produce highly toxic

fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

D. Welding Materials: Comply, with Section II, Part C. ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

E. Gasket Material: Thickness, material, and type suitable for fluid to be handled, and design temperatures and pressures.

2.5 GENERAL DUTY VALVES

A. General duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 15 Section "Valves." Special duty valves are specified below by their generic name; refer to Part 3 Article "VALVE APPLICATION" for specific uses and applications for each valve specified.

2.6 SPECIAL DUTY VALVES

A. Balancing Valves, up to 3 inch: 125 psig water working pressure, 250 deg F maximum operating temperature, bronze body, (4 inch valves to be cast iron body), ball valve with calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening. Valve shall have tapped and plugged drain connection and molded insulation cover. Include differential pressure meter readout kit with hoses, shut-off and vent valves and carrying case.

B. Combination Balancing and Shutoff Valves, up to 12 inch: 125 psig water working pressure, 230 degree F maximum operating temperature, cast iron body, "Y" pattern equal percentage globe style. Valve handles shall have a minimum of 4 full 360 degree revolutions from shut-off to full open. Provide with 2 metering ports on each side of valve, with integral check valves and seals. Valve shall have tapped and plugged drain connection and pre-formed molded insulation cover. Include differential pressure meter readout kit with hoses and carrying case.

C. Balancing Valves Larger than 12 inch: Use calibrated butterfly valves with locking device and a separate flow meter.

D. Pump Discharge Valves: 175 psig working pressure, 300 deg F maximum operating temperature, cast-iron body, bronze disc and seat, stainless steel stem and spring, and "Teflon" packing. Valves shall have flanges connections and straight or angle pattern as indicated. Features shall include non-slam check valve with spring-loaded weighted disc, and calibrated adjustment feature to permit regulation of pump discharge flow and shutoff.

E. Safety Relief Valves: 125 psig working pressure and 250 deg F maximum operating temperature; designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber. Select

valve to suit actual system pressure and Btu capacity.

2.7 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150 psig working pressure, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8 inch discharge connection and 1/2 inch inlet connection.

B. Pump Suction Diffusers: Cast-iron body, with threaded connections for 2 inch and smaller, flanges connections for 2-1/2 inch and larger; 175 psig working pressure, 300 degree F maximum operating temperature; and complete with the following features:

1. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
2. Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
3. Disposable fine mesh strainer to fit over cylinder strainer.
4. Permanent magnet, located in flow stream, removable for cleaning.
5. Adjustable foot support, designed to carry weight of suction piping.
6. Blowdown tapping in bottom; gauge tapping in side.

C. Diverting Fittings: Cast iron body with threaded ends, or wrought copper with solder ends; 125 psig working pressure, 250 degree F maximum operating temperature. Indicate flow direction on fitting.

PART 3 - EXECUTION

3.1 PIPE APPLICATIONS

A. Install Type L, drawn copper tubing with wrought copper fittings and solder joints for 2 inch and smaller, above ground, within building. Install Type K, annealed temper copper tubing for 2 inch and smaller without joints, below ground or within slabs.

B. Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger.

3.2 PIPING INSTALLATIONS

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation.

E. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

F. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.

G. Install supply and return piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.

H. Install branch connections to mains using Tee fittings in main with take-off out the bottom of the main, except for up-feed risers which shall have take-off out the top of the main line.

I. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanges devices.

J. Install dielectric waterway fittings to join dissimilar metals.

K. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

L. Install flexible connectors at inlet and discharge connections to pumps (except inline pumps) and other vibration producing equipment.

M. Install strainers as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.

N. Anchor piping to ensure proper direction of expansion and contraction.

O. Brace piping for seismic control per Division 15 Section "Vibration and Seismic Control".

3.3 HANGERS AND SUPPORTS

A. General: Hanger, supports, and anchors devices are specified in Division 15 Section "SUPPORTS AND ANCHORS." Conform to the table below for maximum spacing of supports:

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs.

2. Adjustable roller hangers for individual horizontal runs where shown on the drawings.

3. For multiple horizontal runs, supported on a trapeze hangers.

C. Install hangers with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size-Inch	Steel Pipe Max. Span-Ft.	Copper Pipe Max. Span-Ft.	Min. Rod Size (Inch)
1/2	7	5	1/4
3/4	7	5	1/4
1	7	6	3/8
1-1/2	9	8	3/8
2	10	8	3/8
3	12	10	1/2
4	14	12	5/8
5	16		5/8
6	17		3/4
8	19		7/8
10	22		7/8
12	23		7/8
14			7/8
16			7/8
18			7/8
20			1-1/2
24			1-1/2
30			1-1/2

D. Support vertical runs at each floor.

3.4 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."

B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
2. Purge the pipe and fittings during brazing, with an inert gas (ie., nitrogen or carbon dioxide) to prevent formation of scale.

3. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.

C. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
2. Align threads at point of assembly.
3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

   a. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

D. Welded Joints: Comply with the requirement in ASME Code B31.9-"Building Services Piping."

E. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

3.5 VALVE APPLICATIONS

A. General Duty Valve Applications: Where specific valve types are not indicated, the following requirements apply:

1. Shut-off duty: Use gate, ball, and butterfly valves.
2. Throttling duty: Use globe, ball, and square head plug valves.
3. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.
4. Install balancing valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.
5. Combination balancing and shutoff valves may be used in lieu of separate balancing and shutoff valves.

B. Install balancing valves on the outlet of each heating or cooling element and elsewhere as required to facilitate system balancing.

C. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.

D. Install nonslam check valves on each pump discharge and elsewhere as required to control flow direction.

E. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in the system, at all terminal units and elsewhere as required for system air venting.

B. Install pump suction diffusers on pump suction inlet, adjust foot support to carry weight of suction piping. Support from inertia base when one is used. Install nipple and ball valve in blowdown connection.

C. Install pump discharge valves in horizontal or vertical position with stem in upward position. Allow clearance above stem for check mechanism removal.

3.7 FIELD QUALITY CONTROL

A. Preparation for testing: Prepare hydronic piping in accordance with ASME B 31.9 and as follows:

1. Leave joints including welds uninsulated and exposed for examination during the test.
2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanges joints at which blinds are inserted to isolate equipment need not be tested.
5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.

B. Testing: Test hydronic piping as follows:

1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.
3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not

exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code For Pressure Piping, Building Services Piping.

5. After the hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

3.8 ADJUSTING AND CLEANING

A. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

B. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

C. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.9 START-UP

A. Fill system and perform initial chemical treatment.

B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

C. Before operating the system perform these steps:

1. Open valves to full open position. Close coil bypass valves.
2. Remove and clean strainers.
3. Check each pump for proper direction; correct improper wiring.
4. Set automatic fill valves for required system pressure.
5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
6. Set temperature controls so all coils are calling for full flow.
7. Check operation of automatic bypass valves.
8. Check and set operating temperatures of chillers, heat exchanger and cooling towers to design requirements.
9. Lubricate motors and bearings.

3.10 COMMISSIONING

A. Refer to Section 01810 "Building System Commissioning" for additional requirements.

END OF SECTION 15510

SECTION 15540 - HVAC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this Section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."
3. "Basic Piping Materials and Methods."

1.2 SUMMARY

A. This Section includes the following types of HVAC pumps:

1. Base-mounted, separately coupled, double-suction pumps.

B. Related Sections: The following sections contain requirements that relate to this section:

1. Division 15 Section "Electrical Requirements for Mechanical Equipment" for electric motors, variable speed drives, connections, and accessories.
2. Division 15 Section "Meters and Gauges" for temperature and pressure gauges and connectors.
3. Division 15 Section "Vibration and Seismic Control" for inertia pads, isolation pads, spring supports, and spring hangers.
4. Division 15 Section "Control Systems" for control wiring between pumps, and between pumps and field-installed control devices.

1.3 SUBMITTALS:

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Product data including certified performance curves of selected models indicating selected pump's operating point, weights (shipping, installed, and operating), furnished specialties, and accessories.

1.4 QUALITY ASSURANCE

A. Hydraulic Institute Compliance: Design, manufacture, and install HVAC pumps in accordance with "Hydraulic Institute Standards."

B. National Electrical Code Compliance: Provide components complying with NFPA 70 "National Electrical Code."

C. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): HVAC pumps shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in

OSHA Regulation 1910.7.

D. UL Compliance: Provide HVAC pumps which are listed and labeled by UL, and comply with UL Standard 778 "Motor Operated Water Pumps."

E. NEMA Compliance: Provide electric motors and components that are listed and labeled NEMA.

F. Single Source Responsibility: Obtain HVAC pumps from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15010 "Basic Mechanical Requirements".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Base-Mounted Pumps:
   a. Armstrong Pumps Inc.
   b. Aurora Pumps.
   c. Bell & Gossett ITT.
   d. Peerless Pump.
   e. Taco, Inc.
   f. Thrush Company, Inc.
   g. Weinman, Mueller Pump

2.2 PUMPS, GENERAL

A. Pumps and Circulators: Factory-assembled and factory-tested. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated.

B. Design Criteria: Select pump and impeller to meet specified conditions within a plus or minus 5 percent correction factor. The pump capacity head curve shall intersect the specified capacity and head conditions within the maximum efficiency of the impeller furnished. The pump head shall increase continuously from maximum pump capacity to shut-off with the slope of the capacity head curve approaching horizontal at shut-off. Pump operating speed shall not exceed 1800 RPM unless otherwise indicated.

C. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles.

D. Motors and Electrical Components: Refer to Division 15 Sections “Electrical Requirements for Mechanical Equipment” and “Motors”.

E. Apply factory finish paint to assembled, tested units prior to shipping.

F. Nameplate: Install pump nameplate indicating pump operating flow (GPM) and head (TDH). Follow Section 15190 "Mechanical Identification" requirements.

2.3 BASED-MOUNTED, SEPARATELY-COUPLED, DOUBLE-SUCTION PUMPS

A. General Description: Pumps shall be base-mounted, centrifugal, separately-coupled, double-suction, single-stage, bronze-fitted, axially split case design, and having an impeller mounted between bearings. Temperature and pressure ratings: 175 psig working pressure and 225 deg F continuous water temperature.

B. Casings Construction: Cast iron, with ANSI B16.1, Class 250 flanged piping connections, threaded gauge tappings at inlet and outlet flange connections, and threaded drain plug at the bottom of the volute.

C. Impeller Construction: Non-ferrous, molded statically, and dynamically balanced, closed, double-suction, keyed to shaft.

D. Pump Shaft and Sleeve Bearings: Steel shaft, with bronze sleeve.

E. Pump Shaft Bearings: Grease-lubricated ball bearings contained in a cast iron housing.

F. Seals: Mechanical seals consisting of stainless steel or brass rotating ring, stainless steel spring, ni-resist seat, and flexible bellows and gasket.

G. Pump Couplings: Flexible, EPDM coupling, capable of absorbing torsional vibration and shaft misalignment.

1. Provide ANSI B15.1, Section 8 and OSHA 1910.219 compliant coupling guard with slotted viewing windows.

H. Mounting Frame: Factory-welded frame and cross members, fabricated of steel channels and angles conforming to ASTM B 36. Fabricate for mounting pump casing, coupler guard, and motor. Grind welds smooth prior to application of factory finish. Motor mounting holes for field-installed motors shall be field-drilled.

I. Motor: Flexible-coupled to pump, with adjustable alignment on mounting frame. Motors shall be inverter duty type for all pumps with or without variable frequency drives as shown on drawings. Refer to Section 15170 – "Motors".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of HVAC pumps.

B. Examine rough-in for piping systems to verify actual locations of piping connections prior to installation.

C. Examine equipment foundations and inertia bases for suitable conditions where pumps are

to be installed.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with the manufacturer's written installation and alignment instructions.

B. Install pumps in locations and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support base-mounted pumps and piping separately so that the weight of the piping system does not rest on the pump.

D. Secure base-mounted pumps to anchor bolts installed in concrete equipment bases. Furnish anchor bolts which are to be inserted in concrete pad to concrete Installer. Disconnect coupling halves before setting. Do not reconnect couplings until the alignment operations have been completed.

1. Support pump base plate on rectangular metal blocks and shims, or on metal wedges having a small taper, at points near the foundation bolts to provide a gap of 3/4 to 1-1/2 inch between the pump base and the foundation for grouting.
2. Adjust the metal supports on wedges until the shafts of the pump and driver are level. Check the coupling faces and suction and discharge flanges of the pump to verify that they are level and plumb.

3.3 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundations, after grout has been set and foundations bolts have been tightened, and after piping connections have been made.

1. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance.

B. After alignment is correct, tighten the foundation bolts evenly, but not too firmly. Fill the base plate completely with nonshrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.

1. Alignment tolerances shall meet manufacturers recommendations.

3.4 CONNECTIONS

A. General: Install valves and piping specialties that are same size as the piping connecting the pump.

B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.

C. Install a nonslam check valve, balancing valve and shut-off valve or a triple duty valve on

the discharge side of pumps.

D. Install a strainer and shut-off valve or suction diffuser and shut-off valve on the suction side of pumps. Suction diffuser shall be used where five (5) pipe diameters of straight pipe cannot be maintained before inlet to pump.

E. Install flexible connectors on the suction and discharge side of each base-mounted pump. Install flexible connectors between the pump casing and the discharge valves, and upstream the pump suction diffuser.

F. Install common pressure gauge with valved connections to the suction side of the inlet strainer and discharge of each pump at the integral pressure gauge tappings provided.

3.5 FIELD QUALITY CONTROL

A. Check suction lines connections for tightness to avoid drawing air into the pump.

3.6 START-UP

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Lubricate oil-lubricated bearings.
2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.
3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:

1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.
2. Open the valve in the cooling water supply to the bearings, where applicable.
3. Open the cooling water supply valve if the stuffing boxes are water-cooled.
4. Open the sealing liquid supply valve if the pump is so fitted.
5. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.
6. Open the recirculating line valve if the pump should not be operated against dead shutoff.
7. Start the motor.
8. Open the discharge valve slowly.
9. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland

immediately, but let the packing run in before reducing the leakage through the stuffing boxes.

10. Check the general mechanical operation of the pump and motor.
11. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.

C. If the pump is to be started against a closed check valve with the discharge shut-off valve open, the steps are the same, except that the discharge shut-off valve is opened some time before the motor is started.

D. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.7 COMMISSIONING

A. Refer to Section 01810 “Building System Commissioning” for additional requirements

END OF SECTION 15540

SECTION 15589 - PIPE CLEANING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish all labor, material, tools and equipment required to clean and chemically treat all piping systems.

B. This work shall be performed by an organization which specializes in pipe cleaning and water treatment.

1.2 SUMMARY

A. Piping systems to be cleaned:

1. Chilled water piping systems.
2. Condenser water piping systems.

B. Related Sections:

1. Division 15 Section "Basic Mechanical Requirements".
2. Division 15 Section "Hydronic Piping".

1.3 QUALITY ASSURANCE

A. Codes and Standards:

1. Chemical Standards: Provide only chemical products which are acceptable under state and local pollution control regulations. Chromates and phosphates are prohibited.

PART 2 - PRODUCTS AND EXECUTION

2.1 PIPE CLEANING

A. Method

1. The cleaning solution shall be circulated throughout the systems to remove light lime, oil, grease, algae, oxides and other wastes. Strainers, mudlegs, traps, drains and equipment low points shall be thoroughly flushed out. The circulation and flushing shall be performed as may times as required until the drained water runs clean and free from all deposits and discoloration. A protective coating shall then be applied to all inner surfaces, which will inhibit oxidation as well as protect the metals against impurities that may be present in the system fluid.

B. Materials

1. The cleaning and treating materials used for this purpose must have been in use

successfully for at least five years in comparable systems. It shall be compounded on noncorrosive, non-toxic, non-alkaline, and non-injurious ingredients that have been investigated and reported as a neutral compound by a recognized, unbiased engineering firm or laboratory, other than the submitting company's open laboratory.

C. Application

1. It shall be the sole responsibility under this Section for the application of this process. Supply all labor, materials, and pumping equipment for this purpose. Keep a competent supervisor and/or equipment operator continuously at the site from commencement of the work until completion. None but experienced men shall operate this pumping equipment. Any repairs or servicing of components of these systems shall be done under the installing sections.

D. Approved Cleaning Organizations

1. Oakite Chemical Corp.
2. Drew Chemical Co.
3. The Mogul Corp.
4. Diversy Water Technologies.
5. Garratt – Callahan Company.

2.2 COMMISSIONING

A. Refer to Section 01810 “Building System Commissioning” for additional requirements.

END OF SECTION 15589

SECTION 15711 - FACTORY-FABRICATED COOLING TOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."

2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

A. Extent of factory-fabricated cooling tower work required by this section is indicated on drawings and schedules and by requirements of this section.

B. Types of factory-fabricated cooling towers specified in this section include the following:

1. Induced-draft, propeller fan, crossflow.

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Other Division 15 sections for piping, specialties, pumps, automatic temperature control and water treatment required external to cooling towers for installation.

1.3 SUBMITTALS

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Certifications: Submit required certifications and written tests results for required testing.

C. Sound Data: Provide sound data for the combined cooling tower assembly.

1.4 QUALITY ASSURANCE

A. Provide manufacturer's certification of tower cooling capacity, based on factory-performance tests, and provide performance curve plotting Leaving-Water Temperature (LWT) against Wet-Bulb Temperature (WBT).

B. Certify tower wind resistance to withstand pressure indicated, in any direction.

C. Certify earthquake resistance against loading as indicated.

D. Codes and Standards:

1. UL and NEMA Compliance: Provide electric motors and electrical components required as part of factory-fabricated cooling towers, which have been listed and labeled by UL and comply with NEMA Standards.

2. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Electric motors and electrical components shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

3. NEC Compliance: Install cooling towers in accordance with NFPA 70 "National Electrical Code."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15010 "Basic Mechanical Requirements".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide factory-fabricated cooling towers of one of the following:

1. Baltimore Aircoil Co., Inc.

2. Evapco Inc.

3. Marley (The) Cooling Tower Co.

2.2 FACTORY-FABRICATED COOLING TOWERS

A. General: Fabricate cooling towers using manufacturer's standard design, materials, and construction in accordance with published product information, except as otherwise indicated.

B. Type: Induced draft, propeller fan, cross flow, vertical discharge.

C. Size: Refer to the drawings for sizes and additional requirements.

D. Design structural system for the following live loading in addition to tower dead-loads and operating-loads:

1. Wind Loading: 30 psf on exposed vertical surfaces.

2. Earthquake Resistance: Acceleration of 1. G horizontally through center of gravity.

E. Fabricate structural system including assembly of collecting basin and steel casings by one of the following methods:

1. Bolt connections with fasteners having equal or better corrosion-resistance than materials fastened; seal joints to make watertight enclosure.

2. Weld connections and weld metal seams continuously to make watertight.

3. Provide rigging supports on structure for final rigging.

F. Casings: Hot-dipped galvanized steel installed by manufacturer to make tower watertight.

G. Collecting Basin and Sump: Stainless steel designed and installed to support water and to ensure water tightness:

1. Provide integral type collecting basin and sump with lift-out strainer with openings small than nozzle orifices, and with connections for drain, overflow and water make-up.

H. Eliminators constructed of polyvinyl chloride (PVC) shall be provided to effectively remove entrained moisture from the discharge air stream. PVC shall have a flame spread rating of 5 per ASTM E84.

I. Water Distribution System-Water shall be injected and distributed uniformly through a hot-dip galvanized steel spray tree composed of header with built-in strainer, branches with provision for clean-out, and brass spray nozzles. The entire water distribution system shall be accessible from the front of unit for inspection and servicing.

J. Pan Section-The pan section shall be constructed of heavy gauge stainless steel. Basin shall include a depressed center sump with a connection for clean out and draining. Suction connection shall be provided with an anti-vortexing device and large area, hot-dip galvanized steel strainer screens, easily removable for cleaning.

K. Wetted-Surface Fill: Vertical sheets of polyvinyl chloride plastic having flame spread rating of 5 per ASTM E 84, fabricated into wave-formed configurations installed by manufacturer to assure break-up of water into droplets.

L. Drift Eliminators: Polyvinyl chloride plastic, having flame spread rating of 5 per ASTM E 84, fabricated into three-pass configuration to limit drift-loss to indicated maximum percentage of circulating-water flow-rate.

M. Inlet Louvers: Hot-dipped galvanized steel of sufficient thickness and rigidity to prevent visible sagging.

N. Water Distribution System: One of the following materials designed and installed by manufacturer to ensure even distribution of water over wetted-surface-fill.

1. Galvanized steel pipe header and removable galvanized steel pipe branches.
2. Nozzles: Provide removable plastic, brass, or ceramic nozzles.
3. Pressure Drop: Maximum pressure drop of 5 psi.

O. Basin Covers: Stainless steel removable and with handles to prevent debris from entering basin and to inhibit algae growth by eliminating sunlight:

P. Basin Heaters: Provide electric immersion heaters including thermostat and low-water cutout, in weatherproof enclosure, for field wiring. Heaters shall be sized by manufacturer to maintain basin water at 40 deg. F at ambient temperature of 0 deg. F and wind velocity

of 15 mph. Refer to equipment schedule in the drawings.

Q. Water Level Control: Electrode Type

1. With electrode actuating unit for:

   a. Make-up water.
   b. High and low water alarms.

2. Electrode unit mounted in stand pipe external of cooling tower.

   a. Winterize unit with heat trace.

   b. 4 electrodes: stainless steel polyvinyl chloride insulated rods
   c. Top mounted at level portion of tower basin
   d. Suitable electric control relays for make-up water control.
   e. Make-up water control.

      (1) Unit to open make-up water motorized valve when basin water drops below operating level.
      (2) Unit to close make-up water motorized valve when basin water rises above high operating level.

   f. Unit to actuate high and low water alarms when water in basin rises or falls below operating levels.
   g. Galvanized steel vented pipe cover around electrodes to prevent water waves or surges from affecting electrodes.
   h. Make-up control circuits suitable for 120 volt.
   i. Electrode and heater circuits: 120 volt.
   j. Provide suitable transformers, if required.

R. Flow Control Valves: Provide butterfly flow control valves for balancing flow to each distribution basin, and for shut-off during servicing.

S. Fans and Drives:

1. Provide cast-aluminum propeller-fan of adjustable-pitch type.
2. Provide gear-drive including speed reducer.
3. Provide fan guard mounted on top of the cylinder.
4. Provide extended lubrication lines that will allow maintenance personnel to lubricate drive bearings from outside of unit.
5. Fan Bearings: Provide self-aligning ball bearings; include external extended grease lines, and fittings.
6. Motor: Totally enclosed, fan-cooled energy efficient type motor rated for operation with a variable frequency drive.

T. Access: Provide access door at opposite ends of each cooling tower cell. Access doors to be constructed of the same material as the tower casing.

U. Internal Walkway: Each tower shall be equipped with a man-sized access door in each end and internal walk, removable fan guards and fan extension cylinders as required to raise

discharge to bottom of grating. Each tower to be provided with galvanized steel internal walkway between access doors.

V. Fan Vibration Switch and Control Unit

1. Vibration switch for each cooling tower fan with the following:

   a. Watertight NEMA-4 enclosure with continuous gasket and stainless steel Phillips head screws.
   b. Factory prewired resistor heater.
   c. Watertight set button in cover.
   d. Single threaded hib for 3/4 inch steel flexible conduit connector.
   e. Contacts: one (1) N.O. and one (1) N.C.
   f. AC supply to be derived from its respective monitor control unit.
   g. Rain shield of 14 gauge steel, zinc dipped and finished to match motor.
   h. Angle bracket, 1/2 inch steel, zinc dipped, with mounting holes for bracket and switch.
   i. Switch to provide automatic shutdown of respective fan motor in case of abnormal vibration persisting beyond preset monitoring time delay.
   j. Switch mounted in horizontal position perpendicular to the rotational axis of motor and in accordance with manufacturers instructions.
   k. Control unit.

      (1) Suitable for operation at 120V AC, 1 phase 60 Hz. Enclosure to be weatherproof type.

      (2) Start time delay, continuously adjustable, 5 to 240 seconds. Setting to be field approved at test.

      (3) Monitoring time delay, continuously adjustable, 2 to 3 seconds. Setting to be field approved at test.

      (4) Alarm indicating light in separate cast iron box attached and located above control unit, with red jewel.

      (5) Built in provisions for remote alarm and/or indicating light.

      (6) Outer stainless steel cabinet.

      (7) Shut down fan when vibration time exceeds starting and monitoring delays.

      (8) All screws to be stainless steel.

W. Apply phosphatized pretreatment on zinc coated surfaces which have not been mill-phosphatized. Apply gasoline-soluble rust preventative compound on ferrous parts which cannot be galvanized, including shafts and machined parts.

1. Finish components with zinc-coated metal surfaces by one of the following methods:

a. Coat abraded areas and welded areas with galvanizing repair paint. Finish-paint exposed surfaces with zinc chromatized paint.

b. Provide 2-1/4 oz. (per sq. ft. of sheet) zinc coating on basin and sump, after fabrication, by hot-dip galvanizing process. Coat abraded areas and welded areas of work with galvanizing repair paint.

c. Apply to metal surfaces not galvanized, zinc-rich paint which has been tested and accepted by U.L. as being equivalent to hot-dipped galvanized steel.

X. Maximum Permissible Sound Pressure Level: Use 0.0002 microbar as reference. Airborne noise emitted by the cooling tower shall not exceed 80dba at a distance of 50 feet from any cooling tower surface.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which factory-fabricated cooling towers are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. General: Install cooling towers where indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices, to ensure that cooling towers comply with requirements and serve intended purposes.

B. Access: Provide access and service space around and over cooling towers as indicated, but in no case less than that recommended by manufacturer.

C. Support: Install units on structural steel. Anchor cooling tower with removable fasteners.

D. Placement: Mount unit on neoprene pad. Install gaskets or sealants between cooling tower cells. Level units to tolerance of 1/8 inch in 10 feet - 0 inch, in both directions.

E. Condenser Water Piping: Refer to Division 15 section "Hydronic Piping". Provide flanged connections to cooling tower. Connect inlets to cooling tower with shutoff valve, and balancing valve (if 2 or more inlets). Connect outlets with shutoff valves.

F. Drain Piping: Refer to Division 15 section "Drainage and Vent Systems". Connect drain, overflow, and bleed lines to cooling tower as indicated, full size of connection on cooling tower.

G. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 16 sections. Do not proceed

with equipment start-up until wiring installation is acceptable to equipment installer.

3.3 ADJUSTING AND CLEANING

A. Cleaning: Clean inside of cooling tower thoroughly before filling for start-up. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

B. Start-up: Comply with manufacturer's instructions for filling and start-up of operation, but not less than the following:

1. Verify lubrication of rotating parts; lubricate as needed.
2. Verify fan rotation direction.
3. Verify that motor amperage is in accordance with manufacturer's data.
4. Balance condenser water flow to each tower, and to each inlet for multiple inlet towers.
5. Adjust water level control for proper operating level.
6. Adjust bleed valve for indicated percentage of circulated water volume.
7. Balance equalizer lines between multiple towers (if any).
8. Adjust temperature controls and verify operation.

C. Operation Test: Test each cooling tower to show that it will operate in accordance with indicated requirements.

3.4 CLOSEOUT PROCEDURES

A. Provide services of manufacturer's technical representative for one 8-hour day to instruct Owner's personnel in operation and maintenance of factory-fabricated cooling towers.

1. Schedule training with Owner, provide at least 7-day notice to Engineer of training date.

3.5 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts:

1. One spare set of matched fan belts for each belt driven fan.
2. Three spare spray nozzles for each tower cell.
3. One spare gasket for each gasketed access and inspection opening.
4. One valve seat for mechanical water make-up valve.

3.6 COMMISSIONING

A. Refer to Section 01810 "Building System Commissioning" for additional requirements.

END OF SECTION 15711

SECTION 15755 - HEAT EXCHANGERS – PLATE AND FRAME

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

A. Extent of heat exchangers work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. This section includes the specifications for water to water plate and frame heat exchangers.

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Other Division 15 sections for insulation of heat exchangers.
2. Other Division 15 sections for piping, valves, specialties, and controls required in conjunction with heat exchangers.

1.3 SUBMITTALS

A. Refer to Section 15010 "Basic Mechanical Requirements".

1.4 QUALITY ASSURANCE

A. Codes and Standards:

1. ASME Compliance: Construct heat exchangers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII "Pressure Vessels", Division 1.

2. TEMA Compliance: Construct and install heat exchangers in accordance with "Standards of the Tubular Exchanger Manufacturers Association."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15010 "Basic Mechanical Requirements".

PART 2 - PRODUCTS

2.1 WATER TO WATER PLATE AND FRAME HEAT EXCHANGER

A. Plate and frame heat exchangers shall be of capacity as scheduled, and as specified herein. It shall be free standing ASME constructed and stamped.

B. Frame shall be adequately sized to allow for opening and cleaning of the plates. Frames shall be provided with top and bottom guide bars for support and alignment of plates. Top guide bar shall have smooth finished stainless steel surface for roller bearing support of movable end-frame and ease of transport for plate suspension. Bottom guide bar shall also have smooth finished carbon steel surface.

C. Fixed and movable end frames shall be reinforced, flat plate SA-516-70 carbon steel design. Movable frame shall be supported from the top guide bar by a roller bearing and guided by the bottom guide bar.

D. End frames shall be provided with holes to facilitate lifting with bar. Three (3) heavy steel floor base plates for anchor bolts shall be provided.

E. Tightening bolts shall be SA-193-B7 zinc plated carbon steel with fixed SA-194-2H carbon steel nut. Free nuts shall be heavy SA-194-2H carbon steel with heavy duty carbon steel washers.

F. Plates shall be fabricated of 304 stainless steel. All plates shall have provisions for attaching to the upper guide bar from either the top or bottom end. All plates to have internal metal to metal contact points (minimum 150/square feet). Plates thickness shall be selected to withstand full operating pressure in one channel with zero pressure in the adjoining channel. Plate thickness shall not be less than 0.8 mm. Plate design shall provide an enclosing groove for the entire gasket. The gasket groove shall have tapered sides to assure positive seating of the compressed gasket. The gasket groove shall be configured to assure that the compressed gasket does not extend above the top of the groove to preclude blow-out of the gasket. End plates shall be provided at the fixed and movable frames.

G. Nozzles shall consist of a lap joint flanged connection rated for 150 psig.

H. Gaskets shall be one piece molded nitrile rubber securely cemented into the continuous groove in each plate. Inactive port gasket areas shall be vented to the exterior in such a manner that no mixing can occur between fluids. Gaskets shall be designed to be sealed by compression until metal to metal contact between plates is secured after tightening of the pack. All gaskets shall be similar except special end gaskets between end plates and frames.

I. The plate pack shall be completely enclosed in a removable painted, aluminum shroud

designed to protect the plate pack from debris and damage.

J. All exterior steel surfaces shall be sharp steel shot blasted to SSPC-S-6-63 followed by one coat of two-part epoxy spray enamel baked at 250F.

K. Relief valve shall be ASME stamped.

L. Minimum fouling factor shall be 0.0005 each side

M. Manufacturers

1. Baltimore Air Coil Co.
2. Alfa-Laval

N. Mounting: Mount heat exchanges on floor housekeeping pads as indicated, located for required clearance for disassembly.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which heat exchangers are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 ADJUSTING AND CLEANING

A. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.3 SPARE PARTS

A. General: Furnish to Owner, with receipt, one spare gasket for each flanged connection for each heat exchanger.

3.4 COMMISSIONING

A. Refer to Section 01810 “Building System Commissioning” for additional requirements.

END OF SECTION 15755

SECTION 15850 – FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."
2. "Basic Materials and Methods."
3. "Electrical Requirements for Mechanical Equipment."

1.2 SUMMARY

A. This Section includes the following types of air-handling equipment:

1. Propeller fans.

B. Related Sections: The following sections contain requirements that relate to this section:

1. Division 15 Section "Vibration and Seismic Control" for vibration hangers and supports.
2. Division 15 Section "Controls" for control devices.
3. Division 15 Section "Sequence of Operation" for control sequence descriptions.
4. Division 15 Section "Testing, Adjusting, and Balancing" for air-handling systems testing, adjusting, and balancing requirements and procedures.
5. Division 16 Section "Circuit and Motor Disconnects" for disconnect switches.

C. Products furnished but not installed under this Section include roof curbs for roof-mounted exhaust fans.

1.3 SUBMITTALS

A. Refer to Section 15010 "Basic Mechanical Requirements".

B. Product data for selected models, including specialties, accessories, and the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound power ratings.
3. Motor ratings and electrical characteristics plus motor and fan accessories.
4. Materials gauges and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

C. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field

connections.

1.4 QUALITY ASSURANCE

A. UL Compliance: Fans shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators."

B. UL Compliance: Fans and components shall be UL listed and labeled.

C. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 15010 "Basic Mechanical Requirements".

1.6 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of structural steel support members.

B. Coordinate the size and location of wall openings.

1.7 EXTRA MATERIALS

A. Furnish one additional complete set of belts for each belt-driven fan after completion of final air balance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Fans:

a. Acme Engineering & Manufacturing Corp.
b. Barry Blower

c. Carnes
d. Cincinnati Fan & Ventilator Co.
e. Cook (Loren) Co.
f. Greenheck Fan Corp.
g. Penn Ventilation
h. Twin City Fan and Blower Co.

2.2 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required:

1. Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data". Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating". Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.

2.3 FANS, GENERAL

A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

C. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor: 1.5 for motors up to 5 HP, 1.2 for motors 7-1/2 HP and larger.

D. Belts: Oil-resistant, nonsparking, and nonstatic.

E. Shaft Bearings: Provide type indicated, having a median life "Rating Life" (AFBMA L 50) of 200,000, calculated in accordance with AFBMA Standard 9 for ball bearings and AFBMA Standard 11 for roller bearings.

F. Factory Finish: The following finishes are required:

1. Sheet Metal Parts: Prime coating prior to final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.4 PROPELLER FANS

A. General Description: Belt-driven or direct-drive propeller fans as indicated consisting of fan blades, hub, housing, orifice ring, motor, drive, and accessories.

B. Housings: Galvanized, sheet steel with flanged edges, and integral orifice ring.

C. Wheels: Formed-steel blades riveted to a heavy-gauge steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, cast-aluminum blades fastened to cast-aluminum hub. Factory set pitch angle of blades.

E. Drive Assembly: Belt-driven as indicated.

F. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Pulleys: Cast-iron, adjustable-pitch.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
4. Motor and Drive Assembly: Resiliently mounted to the housing.

G. Accessories: The following accessories are required as indicated:

1. Belt Guards: Expanded metal with reinforced edges.
2. Gravity Shutters: Gravity-type shutters with aluminum blades in steel frames, mounted on discharge side of fan.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, housekeeping pads, and other conditions affecting performance of fans.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install fans level and plumb, in accordance with manufacturer's written instructions. Support units as described below, using the vibration control devices indicated. Vibration control devices are specified in Division 15 Section "Vibration and Seismic Controls."

1. Wall Mounted Units: Mount units from structural steel frame.

3.3 CONNECTIONS

A. Electrical Connections: The following requirements apply:

1. Electrical power wiring is specified in Division 16.
2. Temperature control wiring and interlock wiring is specified in Division 15 Section "Controls".
3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.4 ADJUSTING, CLEANING, AND PROTECTING

A. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.5 START-UP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping blocking and bracing.
2. Verify unit is secure on mountings and supporting devices and that connections for electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

B. Starting procedures for fans:

1. Energize motor: Verify proper operation of motor, drive system, and fan wheel.
2. Adjust fan to indicated RPM.
3. Replace fan and motor pulleys as required to achieve design conditions.
4. Measure and record motor electrical values for voltage and amperage.

C. Shut unit down and reconnect automatic temperature control operators.

D. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.

3.6 COMMISSIONING

A. Refer to Section 01810 "Building System Commissioning" for additional requirements

END OF SECTION 15850

SECTION 15970 - CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this Section:

1. "Basic Mechanical Requirements."
2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

A. Provide a new Building Automation System (BAS) to monitor and control all equipment and systems provided by this contract. This shall include reconnecting all existing monitoring and control points, which are part of the chilled water plant and equipment, which is affected by this contract. Control system shall include all control points associated with the chilled water plant. Control system shall be expandable to monitor and control the HVAC system in the entire building.

B. Contractor's option. Instead of providing a new control system, it is up to contractor to expand and modify the existing control system to provide all the control systems required for this project. This shall include upgrading the existing software and workstation as necessary to meet the requirements of this project. The existing control system is the Metasys by Johnson Controls

C. Extent of control systems work required by this section is indicated on drawings and schedules, and by requirements of this section.

1. Control sequences are specified in Division 15 Section "Sequence of Operation."

D. Refer to other Division 15 sections for installation of instrument wells, valve bodies, and dampers in mechanical systems.

E. Refer to Division 16 sections for the following work.

1. Power supply wiring from power source to power connection on motors and unit control panels. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

2. Electrical Contractor shall provide 120 volt, 20 amp circuits and circuit breakers in emergency power panels for all control systems.

F. Provide the following electrical work as work of this section, complying with requirements of Division 16 sections:

1. Control wiring between field-installed controls, indicating devices, and unit control panels.
2. Power wiring for DDC controllers and all other control system components. Provide service from spare 20A circuit breakers in nearest emergency power panel.
3. All monitoring and control wiring required for controls and instrumentation.

1.3 FACTORY MOUNTED EQUIPMENT CONTROLS INTERFACE

A. Control Contractor shall expand and interface with these controls to complete building wide BAS control system. All control points on equipment furnished with factory mounted controls shall be fully accessible through BAS operator workstation.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes; also include installation and start-up instructions.

B. Shop Drawings: Refer to Division 15 Section "Sequence of Operation" for shop drawings; not work of this section.

C. Samples: Submit sample of each type of furnished sensor cover, in accordance with requirements of Division 1.

D. Maintenance Data: Submit maintenance instructions and spare parts list for each type of control device. Include that type data, product data and shop drawings in maintenance manual; in accordance with requirements of Division 1.

E. All documentation, including submittals and as-builts shall be submitted on both hard copy and diskette format, using AUTOCAD version that is acceptable to the Owner and Owner's execution standards.

1.5 QUALITY ASSURANCE

A. Codes and Standards

1. Electrical Standards: Provide electrical components of direct digital control system which have been UL-listed and labeled, and comply with NEMA standards.
2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for direct digital control systems.
3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control

sequences.

4. UL Compliance: Provide direct digital control devices which are UL listed as a signal appliance.
5. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Digital Control Devices shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

C. Install system using competent workmen who are fully trained in the installation of temperature control equipment.

D. Single source responsibility of supplier shall be the complete installation and proper operation of the control systems and shall include debugging and proper calibration of each component in the entire system.

E. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

F. Control systems shall comply with UL 916 PAZX and be so listed at the time of bid.

G. Design and build all system components to be fault-tolerant.

1. Satisfactory operation without damage at 110% and 85% of rated voltage and at plus 3 Hertz variation in line frequency.
2. Static, transient and short-circuit protection on all inputs and outputs.
3. Protect communication lines against incorrect wiring, static transients and induced magnetic interference.
4. Network-connected devices to be A.C. coupled or equivalent so that any single device failure will not disrupt or halt network communication.
5. All real time clocks to be battery-backed for a minimum 72 hours.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND INSTALLERS

A. Manufacturers: Subject to compliance with requirements, provide control system by one of

the following:

1. Honeywell
2. Siemens
3. Automatic Logic
4. Johnson Controls

B. Installers: The control system shall be installed by a branch or franchise office of one of the acceptable manufacturer.

2.2 NETWORKING COMMUNICATIONS

A. Access to system data shall not be restricted by the hardware configuration of the building automation system. The hardware configuration of the BAS network shall be totally transparent to the user when accessing data or developing control programs.

B. Peer-to-Peer Network Level:

1. Operator workstations and DDC Controllers shall directly reside on a network such that communications may be executed directly between DDC Controllers, directly between workstations and between DDC Controllers and workstations on a peer-to-peer basis.
2. All operator devices either network resident or connected via dial-up modems shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer network. Access to data shall be based upon logical identification of building equipment. No hardware or software limits shall be imposed on the number of devices with global access to the network data.

C. Open Protocol Interface to BAS DDC Network

1. An Open Protocol Master Panel (OPM) shall be provided with one RS-232C or RS-485 communications port for access by the Building Automation System for communication interface with the respective chiller unit control. The OPM shall permit communication between the unit controllers and the building automation system DDC network. Only manufacturers of proven compatibility shall be allowed. This communications port shall permit the Building Automation System access to the respective unit controllers for Read Only and Read/Write memory locations as follows:

   a. "Read Only" are memory locations within the unit controller which stores the current unit status and previous faults. By reading these memory locations, the building Automatic System shall be able to communicate to and monitor the exact values of the unit (i.e. unit status, individual circuit status, alarms and diagnostics.)
   b. "Read/Write" are memory locations with the unit controller which stores the current value and shall allow the Building Automation System to

modify these values to their application requirements. (ie. - Adjust setpoints, executes alarm resets, etc.)

2.3 DDC CONTROLLER

A. Stand-alone Controllers shall be microprocessor-based with a minimum word size of 16 bits. They shall also be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification.

B. Each DDC Controller shall have sufficient memory, a minimum of 1 megabyte, to support its own operating system and databases, including:

1. Control processes
2. Energy management applications
3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
4. Historical/trend data for points specified
5. Maintenance support applications
6. Custom processes
7. Operator I/O
8. Dial-up communications
9. Manual override monitoring

C. Each DDC Controller shall support:

1. Monitoring of the following types of inputs, without the addition of equipment outside the DDC Controller cabinet:

   a. Analog inputs
      (1) 4-20 mA
      (2) 0-10 Vdc
      (3) Thermistors
      (4) 1000 ohm RTDs

   b. Digital inputs

      (1) Dry contact closure
      (2) Pulse Accumulator
      (3) Voltage Sensing

2. Direct control of pneumatic and electronic actuators and control devices. Each DDC Controller shall be capable of providing the following control outputs without the addition of equipment outside the DDC Controller cabinet:

   a. Digital outputs
      (1) Contact closure

b. Analog outputs

(1) 0-20 psi
(2) 4-20 mA
(3) 0-10 Vdc

D. Each DDC Controller shall have a minimum of 10 per cent spare capacity for future point connection. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than two spares of each implemented I/O type. Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

1. Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.

E. DDC Controllers shall provide at least two RS-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

F. The operator shall have the ability to manually override all automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points. These override switches shall be operable whether the panel processor is operational or not.

1. Switches shall be mounted within the DDC Controllers key-accessed enclosure.
2. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

G. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.

H. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

I. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-

1980.

J. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.

2.4 DDC CONTROLLER RESIDENT SOFTWARE FEATURES

A. General:

1. All necessary software to form a complete operating system as described in this specification shall be provided.
2. The software programs specified in this Section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer for execution.

B. Control Software Description:

1. The DDC Controllers shall have the ability to perform the following pre-tested control algorithms:

   a. Two-position control
   b. Proportional control
   c. Proportional plus integral control
   d. Proportional, integral, plus derivative control
   e. Control loop tuning

2. Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
3. The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
4. Upon the resumption of normal power, each DDC Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

C. DDC Controllers shall have the ability to perform any or all the following energy management routines:

1. Time-of-day scheduling

2. Calendar-based scheduling
3. Holiday scheduling
4. Temporary schedule overrides
5. Start-Stop Time Optimization
6. Automatic Daylight Savings Time Switchover
7. Night setback control
8. Enthalpy switchover (economizer)
9. Peak demand limiting
10. Temperature-compensated duty cycling
11. Fan speed/CFM control
12. Heating/cooling interlock
13. Hot water reset
14. Chilled water reset
15. Condenser water reset
16. Chiller sequencing

    a. All programs shall be executed automatically without the need for operator intervention and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Sequence of Operations.

D. DDC Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. It shall be possible to use any of the following in a custom process:

    a. Any system measured point data or status
    b. Any calculated data
    c. Any results from other processes
    d. User-defined constants
    e. Arithmetic functions (+, -, *, /,square root, exp, etc.)
    f. Boolean logic operators (and/or, exclusive or, etc.)
    g. On-delay/off-delay/one-shot timers

2. Custom processes may be triggered based on any combination of the following:

    a. Time interval
    b. Time-of-day
    c. Date
    d. Other processes
    e. Time programming
    f. Events (e.g., point alarms)

3. A single process shall be able to incorporate measured or calculated data from any and all other DDC Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC Controllers on the

network.

4. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
5. The custom control programming feature shall be documented via English language descriptors.

E. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
3. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs.
4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.

    a. Each DDC Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assignable to any number of points in the Controller.

5. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.

F. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.

1. DDC Controllers shall store point history data for selected analog and digital inputs and outputs:

    a. Any point, physical or calculated may be designated for trending. Any

point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples.

2. Trend data shall be stored at the DDC Controllers and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in 3rd party personal computer applications.
3. DDC Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary. Provide capability to view or print trend and tuning reports.
   a. In automatic mode, the controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.
   b. For troubleshooting in manual mode, the operator shall be able to select variables to override default values. Calculated PID gains shall then be reviewed before they are inserted into the selected LOOP statement.
   c. Loop tuning shall be capable of being initiated either locally at the DDC Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

G. DDC Controllers shall automatically accumulate and store run-time hours for digital input and output points as specified in the point I/O summary.

1. The totalization routine shall have a sampling resolution of one minute or less.
2. The user shall have the ability to define a warning limit for run-time totalization. Unique, user-specified messages shall be generated when the limit is reached.

H. DDC Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for user-selected analog and digital pulse input type points as specified in the point I/O summary.

1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g., KWH, gallons, BTU, tons, etc.).
2. The totalization routine shall have a sampling resolution of one minute or less.
3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

I. DDC Controllers shall have the ability to count events such as the number of times a pump

or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for points as specified in the point I/O summary.

1. The event totalization feature shall be able to store the records associated with a minimum of 9,999.9 events before reset.
2. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.5 APPLICATION SPECIFIC CONTROLLERS (ASC)

A. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs).

B. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Provide the following types of ASCs as a minimum:

1. Central System Controllers
2. Terminal Equipment Controllers

C. Central System Controllers:

1. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Provide a hand/off/automatic switch for each digital output for manual override capability. Switches shall be mounted either within the controller's key-accessed enclosure. In addition, each switch position shall be supervised in order to inform the system that automatic control has been overridden. As a minimum, 50% of the point inputs and outputs shall be of the Universal type, allowing for additional system flexibility. In lieu of Universal inputs and outputs, provide a minimum of 50% spare points of each type via additional point termination boards or controllers.
2. Each controller shall support its own real-time operating system. Provide a time clock with battery backup to allow for stand-alone operation in the event communication with its DDC Controller is lost and to insure protection during power outages.
3. Provide each central system controller with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM or a minimum of 72-hour battery backup shall be provided. All programs shall be field-customized to meet the user's exact control strategy requirements. Central System controllers utilizing pre-packaged or canned programs shall not be acceptable. As an alternative, provide DDC Controllers for all central equipment in order to meet custom control strategy requirements.
4. Programming of central system controllers shall utilize the same language and code as used by DDC Controllers to maximize system flexibility and ease of use.

Should the system controller utilize a different control language, provide an DDC Controller to meet the specified functionality.

5. Local alarming and trending capabilities shall be provided for convenient troubleshooting and system diagnostics. Alarm limits and trend data information shall be user-definable for any point.
6. Each controller shall have connection provisions for a portable operator's terminal. This tool shall allow the user to display, generate or modify all point databases and operating programs. All new values and programs may then be restored to EEPROM via the programming tool.

D. Terminal Equipment Controllers:

1. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. As a minimum, 50% of the point outputs shall be of the Universal type; that is, the outputs may be utilized either as modulating or two-state, allowing for additional system flexibility. Analog outputs shall be industry standard signals such as 24V floating control, allowing for interface to a variety of modulating actuators. Terminal equipment controllers utilizing proprietary control signals and actuators shall not be acceptable.
2. Each controller shall perform its primary control function independent of other DDC Controller LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during LAN interruption is not acceptable. The controller shall receive its real-time data from the DDC Controller time clock to insure LAN continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via terminals as specified herein. This functionality shall allow for tighter control of space conditions and shall facilitate optimal occupant comfort and energy savings. Controllers that incorporate proportional and integral (PI) control algorithms only shall not be acceptable.

2.6 WORKSTATION INTERFACE

A. Dynamic Color Graphic Displays

1. Color graphic floor plan displays and system schematics shall be constructed for each piece of mechanical equipment, including chilled water systems and condenser water systems, shall be provided by the contractor as indicated in the point I/O summary of this specification to optimize system performance analysis and speed alarm recognition.
2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.
3. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.

4. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
5. The existing Insight graphic generation software will be used to allow the user to add, modify or delete system graphic displays.
    a. The Control System Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical symbols.
    b. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:
        (1) Define symbols
        (2) Position and size symbols
        (3) Define background screens
        (4) Define connecting lines and curves
        (5) Locate, orient and size descriptive text
        (6) Define and display colors for all elements
        (7) Establish correlation between symbols or text and associated system points or other displays
    c. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout or any other logical grouping of points which aids the operator in the analysis of the facility.

B. System Configuration and Definition

1. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

2. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:
    a. Add/delete/modify stand-alone DDC Controller panels
    b. Add/delete/modify operator workstations
    c. Add/delete/modify application specific controllers
    d. Add/delete/modify points of any type and all associated point parameters and tuning constants
    e. Add/delete/modify alarm reporting definition for points
    f. Add/delete/modify control loops
    g. Add/delete/modify energy management applications

h. Add/delete/modify time and calendar-based programming
i. Add/delete/modify totalization for points
j. Add/delete/modify historical data trending for points
k. Add/delete/modify custom control processes
l. Add/delete/modify any and all graphic displays, symbols and cross-reference to point data
m. Add/delete/modify dial-up telecommunication definition
n. Add/delete/modify all operator passwords
o. Add/delete/modify alarm messages

3. Definition of operator device characteristics, DDC Controllers individual points, applications and control sequences shall be performed using instructive prompting software.

   a. Libraries of standard application modules such as temperature, humidity and static pressure control may be used as "building blocks" in defining or creating new control sequences. In addition, the user shall have the capability to easily create and archive new modules and control sequences as desired via a word processing type format. Provide a library of standard forms to facilitate definition of point characteristics. Forms shall be self-prompting and incorporate a fill-in-the-blank approach for definition of all parameters. The system shall immediately detect an improper entry and automatically display an error message explaining the nature of the mistake.
   b. If programming must be done with the PC workstation offline, the BAS contractor shall provide at least 2 operator workstations.
   c. Inputs and outputs for any process shall not be restricted to a single DDC Controller, but shall be able to include data from any and all other network panels to allow the development of network-wide control strategies. Processes shall also allow the operator to use the results of one process as the input to any number of other processes (cascading).
   d. Provide the capability to backup and store all system databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Similarly, changes made at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity. The user shall also have the option to selectively download changes as desired.
   e. Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

2.7 OPERATOR WORKSTATION

A. The workstation shall consist of an IBM or Compaq pentium based personal computer with a minimum of 2 serial communication ports for connection to modems or controllers. For connection to high speed LAN, a LAN communications card shall be added to one of the expansion slots.

B. The computer shall contain a minimum of 6MB of RAM memory and 70MB of hard disk memory.

C. Work stations shall be equipped with a VGA color monitor and a mouse.

D. The CPU and all subsystems shall be capable of operating in an environment of 60 to 80 deg. F with 20 to 80% noncondensing relative humidity.

E. The modem shall be a UDS 9600 V32/5 series or equivalent.

2.8 SENSORS

A. Water Temperature: Similar element to room type, with rigid element rod, handi-box and stainless steel immersion well. Accuracy = +/- 1.0% span = .40 degrees to 250 degrees

B. If required accuracy of +/- .25% shall be provided.

2.9 RELAYS AND SWITCHES

A. Provide relays of the positive and gradual acting type and switches as required for the successful operation of the system. All switches shall include suitable indicating plates.

2.10 ELECTRONIC ACTUATORS

A. Electronic damper and valve actuators of sufficient size to operate device safely and within the required range. Arranged to fail safe at either the normally open or normally closed position in the event of power failure, control failure, fire or freeze-up protections.

1. Install electronic actuators on all valves 1-1/4 and smaller.
2. Install electronic actuators on all single blade control dampers and dampers which are part of life safety systems.

2.11 PNEUMATIC ACTUATORS

A. Size pneumatic actuators to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified. When so specified in sequence of operation, where more than 2 actuators are to be operated in sequence to each other, provide position feedback positive positioners with adjustable startpoint and operating range.

1. Install pneumatic actuators on all valves 1-1/2 inch and larger.

2. Install pneumatic actuators on all multi-blade control dampers not part of life safety system.

2.12 CONTROL VALVES

A. Provide valves of standard manufacturer. Provide position indicators. Valve actuators shall be of sufficient size to operate valves safely within the required range.

B. Select valves to fail safe in normally open or closed position as dictated by freeze, humidity, fire, or temperature protection.

C. Select two-way valves for liquids to have equal percentage characteristics. Select three-way valves for liquids to have linear characteristics. Size valve operators to close valves against 40 PSI shut off head. Size for maximum 10 feet water pressure drop.

2.13 PNEUMATIC AIR PIPING

A. Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B16.18; or wrought-copper solder- joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment.

1. Install 1/2 inch minimum copper tubing from air compressor to central control cabinets.

B. Virgin polyethylene non-metallic tubing, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on polyethylene fittings.

PART 3 - EXECUTION

3.1 SCOPE

A. Provide equipment for the automatic control of:

1. Chilled Water Cooling System
2. Alarm Monitoring Systems
3. Miscellaneous Control Systems

B. Provide all other monitoring/control points shown on drawings.

C. Provide operator work station as specified.

3.2 INSTALLATION

A. General: Install systems and materials in accordance with manufacturer's instructions and

rough-in drawings, and details on drawings. Install electrical components and use electrical products complying with requirements of applicable Division 16 sections of these specifications. Check and verify location of exposed control sensors with plans and room details before installation. Locate center line of thermostat 54 inch above floor.

B. Control Air Piping: Accessible tubing is defined as that tubing run in mechanical equipment rooms; inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc; or above suspended ceilings with easy access. Inaccessible tubing is defined as tubing run in concrete slabs, walls or ceilings with no access.

1. Provide copper tubing with maximum unsupported length of 3 feet- 0 inch, for accessible tubing run exposed to view. Polyethylene tubing may be used in lieu of above, when run within adequately supported, rigid enclosure, such as metallic raceways or EMT. Terminal single-line connections less than 18 inch in length maybe copper tubing, or polyethylene tubing run inside flexible steel protection. Accessible tubing run in concealed locations, such as above suspended ceilings with easy access, etc. maybe copper or polyethylene bundled and sheathed tubing.
2. Install accessible tubing below 8 feet above finished floor in rigid metallic conduit.
3. Provide copper or polyethylene tubing for inaccessible areas, other than in concrete pour. If polyethylene tubing is used, install in EMT or use vinyl-jacketed polyethylene tubing.
4. Provide copper or polyethylene tubing when installed in concrete pour. If copper is used, protect at floor line with EMT extending 6 inch above floor and 6 inch into pour. Pressure test before and after pour for leak and pinch. If polyethylene is used, provide EMT conduit in pour and extend 6 inch above floor line; pull tubing through conduit after pour.
5. Pressure test control air piping at 30 psi for 24 hours. Test fails if more than 5 psi
6. Fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support tubing neatly.
7. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system.
8. Leave a minimum of two spares in bundled plastic tubing.
9. Do not attach rigid air piping, raceways, etc. to air moving equipment.

C. Unit Mounted Equipment: Ship electric-pneumatic relays, pneumatic-electric switches, valves, dampers, damper motors to system manufacturer for mounting and wiring at factory.

D. Control Wiring: Install control wiring, without splices between terminal points, number-coded or color-coded. Install in neat workmanlike manner, securely fastened. Accessible wiring is defined as that wiring run in mechanical equipment rooms; inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; or above suspended ceilings with easy access. Inaccessible wiring is defined as wiring run in concrete slabs; walls or ceilings with no access.

1. Install all circuits over 25-volt in electric metallic Raceway according to Division 16 Section "Low Voltage Wiring and Cables".
2. Install low voltage circuits under 25-volt in accordance with Division 16 Section "Control/Signal Transmission Media".

E. Install the following wiring in conduit:

1. All inaccessible wiring.
2. All exposed wiring in occupied areas.
3. All exposed wiring below 8 feet above finished floor in mechanical rooms and equipment rooms. Install in rigid metallic conduit.
4. All wiring associated with life safety systems.

3.3 ADJUSTING AND CLEANING

A. Start-up: Start-up, test, and adjust control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Final Adjustment: After completion of installation, adjust sensors, control valves, motors and similar equipment provided as work of this section.

1. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

D. System Operation Check-Out

1. Upon completion of system installation and after testing and balancing of all HVAC systems, set all control valves, motors, and other equipment provided and place them in complete operating condition and certify, in writing, that the system is operating properly and that all systems have been checked point-by-point.
2. Trend logs of the following input data shall be submitted to the Architect/Engineer for review and approval to provide satisfactory operation of the control system:
   a. Chiller water temp.
   b. Condensing water temp.
3. Trend logs shall incorporate data logged over a 48 hour period at 30 minute intervals. Data shall be combined as to show operation of a complete air handling system over the same logging period.
4. Witnessed validation demonstration to Owners authorized representative shall consist of:
   a. Display and demonstrate each data entry template to show site specific

customizing capability. Demonstrate parameter changes.

b. Execute menu tree.

c. Execute digital and analog commands in English and graphic mode.

d. Demonstrate all specified diagnostics.

e. Demonstrate scan, update, and alarm responsiveness.

E. Actuators

1. All outdoor actuators shall be electric type.

2. All indoor actuator associated with the chilled water plant shall operate with 60 psi air pressure. Provide pressure reducing valve.

3.4 CLOSE-OUT PROCEDURES

A. Owner's Instructions: Provide services of manufacturer's technical representative for one 8-hour day on site to instruct Owner's personnel in operation and maintenance of control systems.

1. Schedule instruction with Owner; provide at least 7-day notice to contractor and engineer of training date.

B. Enroll two system operators in a modular type of training program and provide the owner with six (6), 4 hour modules.

C. All system programming is to be completed to the satisfaction of the Owner. If after preliminary use of the system, and/or training, the increased understanding of the system's features and capabilities necessitates reprogramming to any extent, it is to be performed at no additional cost. During the warranty period, this shall include changes to room names and numbers.

3.5 MAINTENANCE

A. The control system Contractor shall present to the Owner a no cost Preventative Maintenance Contract to cover service incidental to the continued proper performance of the BAS and devices during the guarantee period. Provide a minimum of 4 inspections.

B. The control system Contractor shall provide quarterly training during the warranty period in sessions of 4 hours each to keep Owner's maintenance personnel current in the operation of this system. Scheduling of training will be the responsibility of the BAS Contractor, which will be signed for by the Owner's representative.

3.6 DEFECTIVE WORK AND MATERIALS

A. Any material or work found on inspection to be defective or not in strict conformance with requirements of the specifications, or defaced or injured through the acts of fire or elements or any other cause shall be removed immediately from the premises and satisfactory materials or work or both substituted therefore without delay.

B. If the contractor does not remove such materials condemned by the engineer within the time limit fixed by written notice, the owner may cause the same to be done and may store all materials at the expense of the contractor. If the contractor does not pay the expense of such removal within ten (10) days thereafter, the Owner may, upon ten (10) days written notice, sell such materials at auction or at a private sale and shall account for the net proceeds thereof, after deducting all costs and expenses that h should have been borne by the contractor.

C. No previous inspection or certificates of payment shall be held as an acceptance of defective work or materials, or to relieve the contractor from obligations to furnish sound materials in accordance with contract requirements.

3.7 GUARANTEE

A. All hardware components, parts, and assemblies, and system software components of the control system shall be guaranteed against defects in material and/or installation of a period of one year after final written acceptance by the Owner. Expressed warranties are conditionally based on the maintained in accordance with the manufacturer's recommendations. Any manufacturing defects arising during this warranty period shall be corrected without cost to the Owner.

3.8 COMMISSIONING

A. The execution of this contract includes the system's commissioning by an independent commissioning agent.

B. Cooperation with the commissioning agent.

1. The contractor and all vendors shall cooperate with the commissioning agent in the execution of all Commissioning activities by providing manpower, equipment, written submittals and all other support required by Section 01810 of these specifications. It shall be the responsibility of all parties to this work to review and comply with these requirements and the requirements of the commission plan issued for this project.

END OF SECTION 15970

SECTION 15985 - SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 Sections apply to this section:

1. "Basic Mechanical Requirements."

1.2 SUMMARY

A. Sequence of operation is hereby defined as the manner and method by which controls function. Requirements for each type of control system operation are specified in this section.

B. Operating equipment, devices, and system components required for control systems are specified in other Division 15 automatic temperature control sections of these specifications.

C. All existing monitoring and control points associated with the existing chillers shall remain in operation.

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings for each system automatically controlled, containing the following information:

1. Schematic flow diagram of system showing fans, pumps, chillers, cooling towers, heat exchangers, valves and control devices.
2. Label each control device with setting or adjustable range of control.

PART 2 - PRODUCTS (not applicable to this section).

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Provide all devices, sensors, controllers, control points, software, hardware, wiring, etc., necessary to make the system operate as described in the control sequences and in this section.

B. Provide control points for all interface points provided with all equipment in this project.

C. All set points shall be adjustable through the graphic screens in the workstation, without the need for computer programming.

D. Provide graphics representation for every system provided by the contract, including every chiller, cooling tower, every pump, fan, and control device.

E. All pumps shall be provided with status points by the use of differential pressure transmitters.

F. Provide a control point for every alarm point.

3.2 SEQUENCE OF OPERATION

A. Refer to the drawings for a detailed description of the sequence of operation.

3.3 CHILLED WATER PLANT

A. Each of the existing chillers include the following existing monitoring devices which need to be reconnected to the new system:

1. Status.
2. Start/stop
3. Leaving chilled water set point.
4. Current comp. Motor
5. Current percentage
6. Current limit setup
7. Current limit actual setpoint
8. Pulldown demand setpoint
9. Flow switch status
10. Compressor status.
11. Evap refrigerant temp
12. Cond refrigerant temp
13. cond subcooling temp
14. Liquid line refrigerant temp
15. Compressor suction temp.
16. Comp superheat suction
17. Disch refrigerant temp
18. Oil temp – feed
19. Oil temp – sump
20. Evaporator refrigerant press
21. Cond refrigerant press
22. Oil differential pressure

23. Low oil pressure
24. High oil pressure
25. Vent solenoid
26. Anti recycling timer
27. Operational code mode
28. Operational mode
29. Safety code
30. Oil pressure – feed
31. Oil pressure net
32. Chiller run time
33. Chiller number of starts

B. The existing system also includes other monitoring and control points which need to be included in the control system:

1. Penthouse make up water temperature
2. Heat trace Outdoor set point temperature
3. Heat trace status
4. Heat trace start/stop
5. Refrigerant alarm.

3.1 COMMISSIONING

A. The execution of this contract includes the system's commissioning by an independent commissioning agent.

B. Cooperation with the commissioning agent.

1. The contractor and all vendors shall cooperate with the commissioning agent in the execution of all Commissioning activities by providing manpower, equipment, written submittals and all other support required by Section 01810 of these specifications. It shall be the responsibility of all parties to this work to review and comply with these requirements and the requirements of the commission plan issued for this project.

3.4 ALARMS

A. Provide reporting and logging of all alarm points indicated on the drawings at the operators work station in addition to alarms initiated by system set points being out of range.

END OF SECTION 15985

SECTION 15990 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 15 sections apply to this Section:

1. "Basic Mechanical Requirements."

C. Related Sections: The following sections contain requirements that relate to this section:

D. General requirements for testing agencies are specified in the Division 1 Section Quality Control Services.

E. Other Division 15 Sections specify balancing devices and their installation, and materials and installations of mechanical systems.

F. Individual Division 15 system sections specify leak testing requirements and procedures.

1.2 SUMMARY

A. This Section specifies the requirements and procedures for total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.

B. Test, adjust, and balance the following mechanical systems:

1. All chillers, heat exchangers and pumps associated with the chilled water plant.
2. All cooling towers and pumps associated with the condenser water system.
3. Miscellaneous exhaust fans.

C. This Section does not include:

1. Specifications for materials for patching mechanical systems;
2. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
3. Requirements and procedures for piping and ductwork systems leakage tests.

1.3 DEFINITIONS

A. Systems testing, adjusting and balancing is the process of checking and adjusting all the

building environmental systems to produce the design objectives. It includes:

1. The balance of water distribution;
2. Adjustment of total system to provide design quantities;
3. Electrical measurement;
4. Establishing quantitative performance of all equipment;

B. Test: To determine quantitative performance of equipment.

C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).

D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

E. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

F. Report forms: Test data sheets arranged for collecting test data in logical order for submission and review. The data sheets should also form the permanent record to be used as the basis for future testing, adjusting, and balancing.

G. Terminal: A point where the controlled medium (fluid or energy) enters or leaves the distribution system. In water systems, these may be heat transfer coils, fan coil units, convectors, or finned-tube radiation or radiant panels.

H. Main: Pipe containing the system's major or entire fluid flow.

I. Submain: Pipe containing part of the systems' capacity and serving two or more branch mains.

1.4 SUBMITTALS

A. Testing, Adjusting and Balancing Agenda:

1. Submit a TAB agenda in accordance with Section 5: Preliminary TAB Procedures of the *Procedural Standards for Testing, Adjusting and Balancing Environmental Systems*, National Environmental Balancing Bureau, latest edition. Agenda shall include but not necessarily be limited to the following:

   a. Provide a written scope of work identifying all normal and all special testing required.
   b. System Review and Analysis (include documentation of any TAB issues that may interfere with the successful adjustment of the systems to project design criteria);
   c. Provide written confirmation that all balancing and measurement devices

required to meet project requirements are adequately shown and/or specified;

d. Provide a list of instrumentation proposed for the project, indicating the specific uses for each item;

e. Submit TAB Report Outline for final report;

f. Submit sample test report forms to be used for the project; and,

g. Provide special instructions to the TAB team for execution of testing work.

B. Agency Data:

1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.

C. Engineer and Technicians Data:

1. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.

D. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.

E. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:

1. Draft reports: Upon completion of testing, adjusting and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports.
3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders.
4. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions,

separated by divider tabs:

a. General Information and Summary
b. Chilled Water System
c. Condenser Water System
d. Miscellaneous

5. Report Contents: Provide the following minimum information, forms and data:

a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal and name, address, telephone number and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.

b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC or NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.

F. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.5 QUALITY ASSURANCE

A. Agency Qualifications:

1. Employ the services of an independent testing, adjusting and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.

2. An independent testing, adjusting, and balancing agency certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) in those testing and balancing disciplines required for this project, and having at least one Professional Engineer registered in the State in which the services are to be performed, certified by AABC or NEBB as a Test and Balance Engineer.

B. Codes and Standards:

1. NEBB: "Procedural Standards for Testing, Adjusting and Balancing of

Environmental Systems."

2. AABC: "National Standards For Total System Balance".
3. ASHRAE: ASHRAE Handbook, 1995 HVAC Applications Volume, Chapter 34, Testing, Adjusting, and Balancing.

C. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.6 PROJECT CONDITIONS

A. Systems Operation: Systems shall be fully operational prior to beginning procedures.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 PRELIMINARY PROCEDURES FOR HYDRONIC SYSTEM BALANCING

A. Before operating the system perform these steps:

1. Open valves to full open position. Close coil bypass valves.
2. Remove and clean all strainers.
3. Examine hydronic systems and determine if water has been treated and cleaned.
4. Check pump rotation.
5. Clean and set automatic fill valves for required system pressure.
6. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
7. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type.)
8. Set temperature controls so all coils are calling for full flow.
9. Check operation of automatic bypass valves.
10. Check and set operating temperatures of chillers to design requirements.
11. Lubricate all motors and bearings.

3.2 MEASUREMENTS

A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.

B. Provide instruments meeting the specifications of the referenced standards.

C. Use only those instruments which have the maximum field measuring accuracy and are best

suited to the function being measured.

D. Apply instrument as recommended by the manufacturer.

E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.

G. Take all reading with the eye at the level of the indicated value to prevent parallax.

H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

I. Take measurements in the system where best suited to the task.

3.3 PERFORMING TESTING, ADJUSTING, AND BALANCING

A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.

B. Cut insulation and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

C. Patch insulation and housings, using materials identical to those removed.

D. Seal piping, and test for and repair leaks.

E. Seal insulation to re-establish integrity of the vapor barrier.

F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

G. Retest, adjust and balance systems subsequent to significant system modifications, and resubmit test results.

3.4 RECORD AND REPORT DATA

A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.

B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

END OF SECTION 15990

SECTION 16010 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this and the other sections of Division 16.

1.2 RULES AND REGULATIONS

A. Work and materials shall conform to and be executed, inspected and tested in accordance with the latest edition of the National Electric Code and with the governing rules and regulations of federal, state and local governmental agencies.

B. Other codes and standards which will apply to this installation include the current editions of:

1. ANSI C2 - National Electrical Safety Code
2. NEMA Standards
3. NFPA 101 - Life Safety Code
4. Underwriters Laboratories
5. Electrical Testing Laboratories
6. Occupational Safety and Health Act

C. Where governing codes indicate the Drawings and Specifications do not comply with the minimum requirements of applicable codes, be responsible for either notifying the Architect/Engineer in writing during the bidding period of the revisions required to meet code requirements, or providing an installation which will comply with the code requirements.

1.3 SUMMARY

A. This Section includes general administrative, material, and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:

1. Electrical, product general requirements and accesses.
2. Submittals.
3. Coordination drawings.

4. Record documents.
5. Maintenance manuals.
6. Rough-ins.
7. Electrical installations.
8. Cutting and patching.

B. Related Sections: The following sections contain requirements that relate to this section:

1. Division 15 Section "ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT," for factory-installed motors, controllers, accessories, and connections.
2. Section 16050 - BASIC ELECTRICAL MATERIALS AND METHODS, for materials and methods common to the remainder of Division 16, plus general related specifications including:

   a. Access to electrical installations.

1.4 SUBMITTALS

A. General: Follow the procedures specified in Division 1 Section "SUBMITTALS."

B. Submit coordination drawings for the areas specified and those areas defined as "problem" coordination areas during construction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.6 QUALITY ASSURANCE

A. Manufacturers of equipment shall be firms regularly engaged in manufacturing factory fabricated systems and equipment whose products have been in satisfactory use in similar service for not less than 3 years.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Seconds, rejects, or damaged materials will be rejected.

B. The equipment to be provided under these Specifications shall be essentially the standard commercial grade product of the manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer.

C. The listing of a manufacturer for certain equipment and systems does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems shall conform to the Specifications.

2.2 U.L. LISTING

A. All equipment shall bear the Underwriter's Laboratories (UL), or other approved agency, listing label.

B. Wherein an item of equipment is specified to be U.L. Listed, the entire assembly shall be listed by Underwriters Laboratories, Inc. Any modifications to suit the intent of the Specifications, shall be performed in accordance with the National Electrical Code and listed by U.L.

PART 3 - EXECUTION

3.1 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

3.2 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.
2. Verify all dimensions by field measurements.
3. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
4. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to

arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.

5. Distribution Equipment Assembly Selection: The Drawings indicate sizes, profiles, and dimensional requirements of assembly equipment. Equipment having equal performance characteristics and complying with indicated maximum dimensions and profiles may be considered, provided deviations do not change the design concept, intended performance, or code/future extension provision clearances. The burden of proof of equality is on the proposer a minimum of 10 days prior to bid.
6. Protect all equipment and materials from the elements, dirt and other damage from the time it is removed from the point of storage until final acceptance.
7. Equipment shall include the component parts thereof such as disconnect switches, motor controllers, motors, drives, and guards necessary to the satisfactory and safe operation of the equipment.
8. Installation shall include setting equipment to accurate line and grade, leveling equipment, aligning equipment components, providing and installing couplings, bolts, guards, and anchor bolts.
9. All tolerances in alignment and leveling, and the quality of workmanship for each class and stage of work shall be subject to manufacturer's installation instructions.
10. All manufacturer's finished equipment surfaces damaged during construction shall be brought to an "as new" condition by touch up or repainting. Any rust shall be completely removed and the surface primed prior to repainting.
11. Workmanship shall conform to the "Standard of Installation" published by the National Electrical Contractors Association.
12. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from the premises when no longer required.
13. No electrical equipment, raceways or other work of any kind shall be covered up or hidden from view before it has been examined and approved. Any unsatisfactory work or materials shall be removed and corrected immediately.
14. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
15. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
16. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Section 16050 - BASIC ELECTRICAL

MATERIALS AND METHODS.

17. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 MANUFACTURER'S DIRECTIONS AND SUPERVISION

A. Where supervision by a manufacturer is specified, follow all instructions, recommended manufacturer and specified field tests, and other recommendations of the manufacturer. The manufacturer shall supervise the installation, connection, start-up, testing, adjustment, instruction of the Owner and final tests of such equipment or system. Where two or more manufacturer's equipment are interrelated, take responsibility to coordinate their work and provide supervision.

B. Have the manufacturer instruct the Owner in the proper operation and maintenance techniques of all equipment, systems, etc., at the time of completion of all work.

C. Prior to final acceptance by the Owner prepare and submit to the Architect/Engineer for review 3 copies of operation and maintenance (O and M) instructions in printed form for each item of equipment or system installed in the building. Complete instructions for each system shall be assembled and bound in a brochure. Detailed contents of the O and M manuals are as hereinafter specified. Refer to appropriate Division 1 sections for general requirements affecting this work.

3.4 PAINTING:

A. Provide the prime painting of all equipment and materials furnished under Division 16 specifications, unless specifically stated otherwise. In general, all equipment except raceways and galvanized boxes that are not provided with a factory-applied final finish shall be delivered to the job site with a shop-applied prime coat of paint.

3.5 TEST AND INSPECTION

A. Upon completion of the work, notify the Architect/Engineer in writing, that the entire electrical installation has been examined, inspected, tested, calibrated or adjusted as specified and that it is ready for final inspection. Work to be connected prior to final inspection and also to include all of the work specified for "Manufacturers' Directions and Supervision." Include documentation of specified testing and inspection.

B. Prior to each inspection, provide a written certification that each system or piece of equipment to be operated during that test has been tested and does meet design

performance criteria of the Contract Documents.

C. On completion of the work, obtain Certificates of Compliance, and approval or acceptance from all authorities having jurisdiction over the work, and deliver these certificates to the Architect/Engineer. The work shall not be deemed to have reached a state of completion until the certificates have been delivered.

3.6 LOOSE EQUIPMENT

A. Provide four keys for every different piece of electrical equipment which is equipped with a lock.

B. Provide all other loose equipment specified/supplied for use with all systems.

3.7 SHOP DRAWINGS

A. Refer to Division 1 for quantities and types of shop drawings.

B. Shop Drawings Required:

1. Disconnect switches
2. Motor controllers
3. Luminaires
4. Wiring Devices

C. Shop drawings submitted for other than those listed above or specifically required in the appropriate Specification Section will not be reviewed or returned.

3.8 OPERATION AND MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include specific Division 16 Section requirements, and the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting;

disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

B. The minimum information that shall be furnished in the maintenance manual shall include the following:

1. Individual characteristics for trouble shooting sequences for each item of each:
   a. Individual motor controller.
   b. Special system.
2. Catalog cut sheets for every item for which a shop drawing is required.
3. On-hand spare parts list and complete parts list for each:
   a. Individual motor controller.
   b. Special system.
4. Overload element schedule for each motor controller whether individual or in a motor control center.
5. Bolt tightening torques and inspection intervals on each:
   a. Miscellaneous bolted electrical connections.
6. Main and arcing contact adjustment and replacement for each:
   a. Contactor.
   b. Circuit breaker.
   c. Fused switch.
   d. Interrupter switch.
   e. Motor controller.
7. Calibration and exercise procedures and intervals for each:
   a. Control system.
   b. Insulated case breaker.
   c. Molded case breaker.
8. "As designed" and "as left" relay settings.
9. Testing interval and target values for ground fault protection circuit relays.
10. Testing and trouble shooting procedures unique to special systems.
11. Approved special construction details that differ from the details shown on Drawings.

3.9 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1 Section "PROJECT COORDINATION," to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:
   a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
   b. Exterior wall and foundation penetrations.
   c. Fire-rated wall and floor penetrations.
   d. Equipment connections and support details.
   e. Sizes and location of required concrete pads and bases.
2. Coordination drawings shall be provided by Division 16 for the following:
   a. Access door locations
   b. Electrical equipment rooms.
   c. Mechanical equipment rooms.
3. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
4. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

3.10 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, indicate installed conditions for:

1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Major equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Contract Modifications and actual equipment and materials installed.

3.11 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:

   a. Uncover Work to provide for installation of ill-timed Work.
   b. Remove and replace defective Work.
   c. Remove and replace Work not conforming to requirements of the Contract Documents.
   d. Remove samples of installed Work as specified for testing.
   e. Install equipment and materials in existing structures.
   f. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
6. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

   a. Refer to Division 1 Section "DEFINITIONS AND STANDARDS" for definition of experienced "Installer."

3.12 COMMISSIONING

A. The execution of this contract includes the system's commissioning by an independent commissioning agent.

B. Cooperation with the commissioning agent.

1. The contractor and all vendors shall cooperate with the commissioning agent in the execution of all Commissioning activities by providing manpower, equipment, written submittals and all other support required by Section 01810 of these specifications. It shall be the responsibility of all parties to this work to review and comply with these requirements and the requirements of the commission plan issued for this project.

END OF SECTION 16010

SECTION 16011 - REMOVALS, RELOCATIONS AND REARRANGEMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Instructions to Bidders, apply to this Section.

1.2 SUMMARY

A. The Drawings indicate the renovated areas and identify those portions of the existing building where renovation work shall be done. These identified areas of the existing building show new electrical work that shall be furnished and installed as shown.

B. Removals, relocations and rearrangements shall be performed in all identified areas of the existing buildings, as indicated on the Drawings.

C. The Contract Documents include series ED Demolition Drawings that have been developed by the Engineer. These Demolition Drawings shall be interpreted as incomplete, and in general represent existing building electrical conditions.

1. The Demolition Drawings included in the Contract Documents are not to be considered complete or accurate, and are only included to provide Division 16 with the general scope and extent of removals, relocations and rearrangements. Division 16 shall be responsible to visit the site prior to submitting the bid, and verify existing building conditions, in order to more accurately establish all removals, relocations and rearrangements required for the project.
2. The Demolition Drawings include description notes that provide an overall intent of demolition, and what Division 16 responsibilities are to accomplish removals, relocations and rearrangements.

D. Examine the existing structures and installations for the work of any and all trades which will influence the cost of the work on this project. The work shall include removals, relocations and rearrangements as follows:

1. Relating directly or incidental to the work of Division 16.
2. The work of other Divisions which may interfere with disturb or complicate, the performance of the work of Division 16.
3. Involving systems and/or equipment and relocated service lines which shall continue to be used or operated as part of the finished project.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Existing device locations were identified as completely as possible by a site survey and by record documents as available. Division 16 shall be responsible for proper demolition and rework of devices not shown on drawings to conform with intent of documents.

3.2 GENERAL RENOVATION REQUIREMENTS

A. Rearrange existing conduits and wiring to accommodate new circuit arrangements indicated and to maintain continuity of existing circuits feeding devices that are to remain.

B. Be responsible to remove and reinstall existing electrical equipment to accommodate the work of or disturbed by all trades.

C. In such cases where new circuit breakers or fusible switches are to be added to existing panelboards, switchboards, motor control centers, etc., they shall be of the same manufacturer and design as the existing breakers or fusible switches, except as otherwise noted and shall be of the sizes as indicated on the drawings. Wherever necessary, be responsible for rearranging any and all existing circuit breakers within the existing equipment, to accommodate the new circuit breakers being added. Provide additional bus, bus extensions, bolts and hardware, enclosure modifications, directory modifications, etc., required to accomplish these modifications.

3.3 SALVAGING

A. Unless specifically directed otherwise, stockpile removed electrical items on job site for reuse until time or project closeout, then legally remove those from site that the Owner does not wish to salvage.

END OF SECTION 16011

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this Section.

B. Requirements specified in the following sections apply to this Section:

1. Section 16010 - Basic Electrical Requirements

1.2 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with electrical installations as follows:

1. Selective demolition including:

a. Non-destructive removal of materials and equipment for reuse or salvage as indicated.
b. Dismantling electrical materials and equipment made obsolete by these installations.

2. Excavation for underground utilities and services, including underground raceways and equipment.
3. Miscellaneous metals for support of electrical materials and equipment.
4. Joint sealers for sealing around electrical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
5. Access panels and doors in walls, ceilings, and floors for access to electrical materials and equipment requiring maintenance and/or operation.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer for the installation and application joint sealers, access panels, and doors.

B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for

welding processes involved and, if pertinent, has undergone recertification.

1.4 PROJECT CONDITIONS

A. Conditions Affecting Selective Demolition: The following project conditions apply:

1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted or relocated, install temporary and/or permanent services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.

C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do no apply joint sealers to wet substrates.

1.5 SEQUENCE AND SCHEDULING

A. Coordinate the shut-off and disconnection of electrical service with the Owner and the utility company.

B. Notify the Architect/Engineer at least 5 days prior to commencing demolition operations.

PART 2 - PRODUCTS

2.1 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout, recommended for interior and exterior applications.

F. Fasteners: Zinc-coated, type, grade, and class as required.

2.2 ACCESS DOORS

A. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

B. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
2. For gypsum walboard or plaster: Perforated flanges with wallboard bead.
3. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

C. Flush Panel Doors: 14-gage sheet steel, concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism, 1-1/2 hr. "B" labeled.

D. Locking Devices: Flush, screwdriver-operated cam locks.

E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bar Co., Inc.
2. J. L. Industries
3. Karp Associates, Inc.
4. Milcor Dir. Inryco, Inc.
5. Nystrom, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 SELECTIVE DEMOLITION

A. General: Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

B. Materials and Equipment To Be Salvaged: Remove, demount, and disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

D. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the items as shown on Drawings.

E. Perform cutting and patching required for demolition in accordance with Division 1 Section "Cutting and Patching."

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.4 INSTALLATION OF ACCESS DOORS

A. Submit coordination drawings indicating proposed access door locations for review per Section 16010.

B. Install access doors, sized to permit complete access for any concealed and/or inaccessible items of equipment requiring access, maintenance, and/or operation.

1. Assure access to devices per codes and local authorities having jurisdiction.

C. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

D. Adjust hardware and panels after installation for proper operation.

END OF SECTION 16050

SECTION 16110 - RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Instructions to Bidders, and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Sections apply to this Section:

1. Section 16010 - Basic Electrical Requirements
2. Section 16050 - Basic Electrical Materials and Methods
3. Section 16120 - Low Voltage Wires and Cables

1.2 SUMMARY

A. This Section includes raceways for electrical wiring. Types of raceways in this section include the following:

1. Rigid galvanized steel conduit (RGS).
2. Intermediate metal conduit (IMC).
3. Electrical metallic tubing (EMT).
4. PVC externally coated rigid steel conduit.
5. Rigid nonmetallic conduit (RNC).
6. Liquidtight flexible conduit.
7. Conduit bodies.
8. Conduit fittings.

1.3 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1. National Fire Protection Association (NFPA):
2. No. 70 National Electrical Code, the following Articles:

342, Intermediate Metal Conduit
344, Rigid Metal Conduit
350, Liquidtight Flexible Metal Conduit
352, Rigid Nonmetallic Conduit

358, Electrical Metallic Tubing
362, Electrical Nonmetallic Tubing

B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

1. National Electrical Manufacturers Association (NEMA):

a.	NEMA, RN 1, 1986	PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
b.	NEMA, TC 3, 1982	PVC Fittings for Use with Rigid PVC Conduit and Tubing.

2. American National Standards Institute (ANSI):

a.	ANSI-C80.2, 1983	Specification for Rigid Steel Conduit, Enameled.
b.	ANSI-C80.3, 1983	Specification for Electrical Metallic Tubing, Zinc-coated.
c.	ANSI-C80.6, 1986	Intermediate Metal Conduit. (IMC)

3. American Society for Testing Materials (ASTM):

a.	ASTM F 512-84	Standard Specification for Smooth Wall Poly Vinyl Chloride (PVC) Conduit and Fittings for Underground Installation.

C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, or ETL.

1.	UL 6, 1981	Rigid Metal Electrical Conduit.
2.	UL 360, 1986	Liquidtight Flexible Steel Conduit, Electrical.
3.	UL 514B, 1982	Fittings for Conduit and Outlet Boxes.
4.	UL 797, 1983	Electrical Metallic Tubing.
5.	UL 1242, 1983	Intermediate Metal Conduit.

1.4 SEQUENCING AND SCHEDULING

A. Coordinate with other Work as necessary to interface installation of electrical raceways and components with other Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

B. Rigid Metallic Conduit:

1. Allied
2. LTV Steel
3. Wheatland

C. PVC Coated Rigid Steel Conduit and Fittings:

1. Occidental Coating Company
2. Perma-Cote Industries
3. Rob-Roy

D. Rigid Nonmetallic Conduit and Fittings:

1. Can-Tex
2. Carlon
3. Condux
4. IPEX
5. National

E. Liquidtight Flexible Metal Conduit and Fittings

1. Al-flex
2. Allied
3. American Flexible Conduit
4. Anamet, Inc.
5. Electro Flex
6. Liquatite
7. RACO

F. Conduit Bodies

1. Appleton Electric Co.
2. Carlon (PVC)
3. Crouse-Hinds Division, Cooper Industries, Inc.
4. Killark Electric Mfg. Co.
5. O-Z/Gedney

G. Conduit Fittings

1. Arlington
2. Bridgeport Fittings, Incorporated

3. Midwest Electric
4. O-Z/Gedney
5. RACO
6. Steel City
7. Thomas and Betts

2.2 METAL CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit: ANSI C80.1.

B. Intermediate Steel Conduit: UL 1242.

C. PVC Externally Coated Rigid Steel Conduit and Fittings: ANSI C80.1 and NEMA RN 1.

D. Electrical Metallic Tubing and Fittings: ANSI C80.3.

E. Liquidtight Flexible Metal Conduit and Fittings: UL 360. Fittings shall be specifically approved for use with this raceway.

2.3 CONDUIT BODIES

A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements for feeder runs only. Branch circuit use is prohibited. Provide matching gasketed covers secured with corrosion-resistant screws.

B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways. Use bodies with set screw or compression type hubs for EMT according to fitting application specified below.

2.4 CONDUIT FITTINGS

A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Die cast fittings are not acceptable.

B. Rigid Galvanized Steel, Intermediate Steel and Rigid Aluminum Conduit: Use threaded type with bushed connections.

C. Electrical Metallic Tubing Conduit: Use nylon insulated fittings. Steel body set-screw type fittings are acceptable for conduits one-inch and smaller except for mechanical rooms, kitchens and damp locations where threaded compression type are required. Die cast fittings are not acceptable.

D. Rigid Nonmetallic or Coated Conduit: Use fittings designed specifically for conduit type of same manufacturer.

E. Liquidtight Flexible Conduit: Use threaded grounding cone with steel compression ring and tightening gland, steel body with insulated throat.

F. Unlike Conduit: Use connectors which meet individual conduit fittings requirements for both and are UL listed and labeled for such use.

G. Expansion and Deflection Fittings:

1. Conduit movement in straight line direction.
   a. O-Z/Gedney type AX series.
2. Up to 3/4 inch deflection and movement in all directions.
   a. O-Z/Gedney type DX series.
3. Deflection and movement beyond 3/4 inch in all directions.
   a. O-Z/Gedney type AXDX series.

H. Conduit Bushings

1. Rigid Steel and Intermediate Steel Conduit: Threaded, grounded, insulating type with thermosetting or fiber insert in a metal body.
2. Electrical Metallic Tubing Conduit: Identical to rigid steel or intermediate steel conduit bushing on electrical metallic tubing combination coupling.
3. Insulated Grounding Bushings or grounding wedges on metallic conduits.

I. Conduit Seals

1. Cast in place with pressure ring and sealing grommet.
   a. O-Z/Gedney type FSK series with FSKA membrane clamp adapter.
2. Cast in place with two pairs of pressure rings and sealing grommets.
   a. O-Z/Gedney type WSK series.
3. For sealing conduits installed in core-drilled, sleeved, or precast holes.
   a. O-Z/Gedney type CSM series with CSMC membrane clamp adapter.
   b. Thunderline Link-Seal series.

PART 3 - EXECUTION

3.1 CONDUIT RACEWAY APPLICATION

A. Rigid Galvanized Steel Conduit

1. May be used in:
   a. Interior locations.
   b. Direct contact with concrete.

2. Shall be used in:
   a. Exposed exterior locations.
   b. Exposed interior damp or wet locations
   c. Hazardous locations.
   d. Medium voltage interior applications (throughout).
   e. Within seven foot area around boilers, incinerators and other heat producing equipment.
   f. Exposed interior locations within seven feet of the floor for all low voltage power and signal conductors (except electrical rooms).
   g. Interior parking levels and exterior decks where exposed.

B. Intermediate Metallic Conduit

1. May be used in:
   a. All applications noted for rigid galvanized steel conduit except hazardous locations and interior medium voltage cable installations.

C. Electrical Metal Tubing

1. May be used in:
   a. Concealed interior locations above ceilings, in hollow studded partitions and in the cores of concrete masonry unit partitions.
   b. Exposed interior locations above seven feet.
   c. Low voltage electric and communication room applications.
2. Shall be used:
   a. All exposed interior locations above seven feet for conductors of any type.

D. Liquid-tight Flexible Metal Conduit shall be used as specified for flexible metal conduit as follows:

1. Shall be used in:
   a. Final connection to pump motor.
   b. Damp locations.
   c. Mechanical rooms.
   d. Wet locations.
   e. 18 inch to 22 inch long lengths to form a slack "U" between rigid raceway system and motors.
2. Shall not be used in HVAC plenums.

3.2 INSTALLATION

A. General: Install electrical raceways in accordance with manufacturer's written installation instructions, applicable requirements of NEC, and as follows:

1. Minimum conduit raceway size shall be 3/4 inch except switch legs, which may be 1/2 inch and 3/8 inch flexible conduit may be use for final connection to luminaires.
2. Provide supports for raceways as specified elsewhere in Division 16.
3. Cut square, free of burrs due to field cutting or manufacture, and use bushings where necessary.

B. Raceway Routing

1. Conceal in finished rooms except where exposure is clearly indicated. Provide stainless steel escutcheon plates for all finished wall, floor, and ceiling penetrations.
2. Install raceways exposed in mechanical and electrical equipment rooms and electrical closets. Maintain a minimum 7 ft. head room.
3. Install raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.
4. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases provide field bends for parallel raceways.
5. Route raceways as required by job conditions unless dimensioned positions are shown on Drawings. Verify exact locations of all raceways, pull boxes, and junction boxes; resolve any conflicts before installation. Give priority in available space to large steam mains, steam lines that pitch, waste lines, drain lines, large air ducts, and all structural steel, unless indicated otherwise.
6. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.
7. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel. Bends shall exceed minimum bending radii of wire and cable to be run within.
8. Install with not more than three 90 degree bends or more than 100 feet of straight conduit between pull boxes. Provide and install all additional pull boxes to meet this requirement.
9. Minimum Spacing: 3 inches between raceways and cold water or waste piping,

and 6 inches between raceways and parallel steam pipes, condensate pipes, hot water pipes and air ducts.

10. Do not place raceway less than one inch apart where they cross each other.
11. Install to provide adequate grounding between all outlets and the established electrical system ground.
12. Install to prevent water pockets.
13. Make no horizontal raceway runs in masonry walls.

C. Raceway Installation

1. Prevent foreign matter from entering raceways by using temporary closure protection.

2. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

3. When installed embedded in concrete, or, in direct contact with the earth:
   a. Provide rigid galvanized steel or IMC elbows for vertical rise through the concrete.
   b. Provide rigid galvanized steel or IMC conduit for the first ten foot section when leaving a building.
   c. Make watertight with asphaltum or other approved compound applied to conduit joints before assembled.

4. Join raceways with fittings and make joints tight. Use bonding jumpers to provide electrical continuity of the raceway system for all metallic feeder conduits one inch and larger. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Use insulating bushings to protect conductors.

5. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.

6. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

7. Complete installation of electrical raceways before starting installation of conductors within raceways.

8. Install a bonding wire in all flexible metal conduits.

9. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200 lbs. tensile strength. Leave not less than 12 inches of slack at each end of the pull wire. Tag at each end identifying other end location.

10. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid galvanized steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs with floor.

11. PVC externally coated rigid steel conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.

12. If it is necessary to cut holes through webs of beams or girders, call such points to the attention of the Architect with size of hole before proceeding with work. All holes shall be cut no larger than absolutely necessary.

13. Whenever conduit is installed on exposed steel columns, the conduit shall be installed on the column web, and not on the flange.

14. All penetrations through existing floors shall be core drilled and sleeved.

15. All conduit knockouts or holes on electrical apparatus which are not used shall be provided with new plugs to match the NEMA rating of the enclosure.

D. Conduit Fittings:

1. Run with couplings approved for the conduit being used. Running threads and chase nipples will not be accepted in runs of threaded conduit.
2. Generally use mechanical (set-screw) on EMT conduit except-use threaded compression type on EMT conduit within mechanical rooms, and damp locations.

E. Expansion-Deflection Fittings:

1. Install in all raceways at the expansion joints of the building in such a manner that the expansion joints of the building will function properly and not stress any electrical raceways. Movement will be required in all directions.
2. Install on all straight conduit runs 1 inch trade size or larger in excess of 100 feet. Movement will be required in straight line direction only.
3. Maintain grounding continuity at each expansion-contraction fitting.

F. Conduit Seals:

1. Use type "FSK" cast-in-place where conduit passes through foundation walls less than 60 inches below finished grade.
2. Use type "WSK" cast-in place where conduit passes through foundation walls at 60 inches or more below finished grade.
3. Install watertight seals at all conduits passing through horizontal barriers. These seals may be types "FSK, "WSK", or "CSML". Sleeves shall extend at least two inches above the finished floor with 1/2 inch space around the conduit and this space sealed permanently watertight with a removable material (concrete not acceptable).
4. Install where conduits pass through barriers having a 30 degree F or greater temperature differential in the spaces on either side at anytime, and in conduits entering or leaving supply and return air plenums. Install pliable removable plastic compounded in the nearest box at the top of vertical runs and at the hot end of horizontal runs.

3.3 ADJUSTING AND CLEANING

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris before installing or pulling conductors.

END OF SECTION 16110

SECTION 16120 - LOW VOLTAGE WIRES AND CABLES (100-600 VOLTS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Instructions to Bidders, and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 16 Sections apply to this section:

1. Section 16010 - Basic Electrical Requirements.
2. Section 16050 - Basic Electrical Materials and Methods.

1.2 SUMMARY

A. This Section includes wires, cables, and connectors for power systems rated 100 to 600 volts.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following code:

B. NFPA 70 National Electrical Code.

1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.

C. UL Compliance: Provide components which are listed and labeled by UL under the following standards.

1. UL Std. 83 Thermoplastic-Insulated Wires and Cables.
2. UL Std. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.

D. IEEE Compliance: Provide components which comply with the following standard.

1. Std.82 Test procedures for Impulse Voltage Tests on Insulated Conductors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Wire and Cable:

   a. Alflex Corp.
   b. American Flexible Conduit Co.
   c. Cablec Corp.
   d. Carol Cable Co. Inc.
   e. Cerro Wire and Cable Corp.
   f. General Cable Corp.
   g. Pirell Cable Corp.
   h. Rome Cable Corp.
   i. Southwire Company.
   j. Triangle PWC, Inc.

2. Connectors for Wires and Cable Conductors:

   a. AMP
   b. Burndy Corporation
   c. General Electric Co.
   d. Gould, Inc.
   e. Ideal Industries, Inc.
   f. O-Z/Gedney Co.
   g. Raychem Corporation
   h. Square D Company
   i. Thomas and Betts Corp.
   j. 3M Company

2.2 WIRES AND CABLES

A. General: Provide wire and cable suitable for the temperature, conditions and location where indicated.

B. Conductors: Provide solid conductors for power and lighting circuits sizes no. 10 AWG and smaller. Provide stranded conductors for sizes no. 8 AWG and larger.

C. Conductor Material: Copper for all wires and cables.

D. Insulation: Provide insulation type in accordance with Part 3 below.

E. Color Coding:

208/120 Volts		480/277 Volts		Isolated Power	
Phase	Color	Phase	Color	Phase	Color
A	Black	A	Brown	A	Brown
B	Red	B	Orange	B	Yellow
C	Blue	C	Yellow		
Neutral	White	Neutral	Gray	Neutral	Orange
Ground	Green	Ground	Green		

F. Jackets: Factory-applied nylon or PVC external jacketed wires and cables for pulls in raceways over 100-feet in length, for pulls in raceways with more than three equivalent 90 deg. bends, for pulls in conduits underground or under slabs on grade, and where indicated.

2.3 CONNECTORS FOR CONDUCTORS

A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRES AND CABLES

A. General: Install electrical cables, wires and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.

B. Coordinate wire/cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires/cables with other work.

C. Install #12 AWG minimum for circuits 100 volts and above.

D. Increase conductor size as required due to availability. Minimum feeder conductor sizes are shown on Drawings. If increased, be responsible for associated feeder conduit size and increased ground conductor size per NEC.

E. Ground and continuously polarize systems properly throughout following the color coding specified.

F. Install UL Type THHN or THWN wiring in conduit, for branch circuits #10 and smaller.

G. Install UL Type XHHW or THHN wiring in conduit, for feeders and branch circuits #8 and larger.

H. Install UL TYPE XHHW or THWN wiring in conduit, for feeders and branch circuits installed outside of the building envelope, in raceway in contact with soil, or whenever raceway may be subject to moisture and/or condensation.

I. Install UL Type XHHW wiring in conduit for isolated power branch circuits.

J. Pull conductors simultaneously where more than one is being installed in same raceway.

K. Use of pulling compound or lubricant is to be avoided unless absolutely necessary; compound used must not deteriorate conductor or insulation, and be one of the following:

1. Ideal-Aqua-Gel
2. Polywater
3. Yellow 77

L. Use pulling means including fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway.

M. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.

N. Provide conductors of the same size from the protective device to the last load.

O. Make conductor length identical for parallel feeders.

P. Install wiring in conduits buried in plaster or in poured concrete after the encasing medium is set and dry and then only after conduits have been swabbed out.

Q. Support conductors in vertical raceways. One cable support shall be provided at the top or as close to the top as practical, plus a support for each additional interval of spacing per Table 300-19a of the NEC.

R. Provide slack wire for all future connections with ends of wires taped and blank box covers installed.

S. Do not bend cables, either permanently or temporarily during installation to radii less than that recommended by the manufacturer.

T. Use conductors with 90 degree C insulation when wiring is within seven feet of, passing over or attached to the following:

1. Boilers and other heat producing equipment.
2. Hot water heaters.

U. Keep conductor splices to a minimum.

V. Splices, Taps and Terminations

1. Make splices and taps in wiring #10 AWG and smaller mechanically and electrically secure with mechanical pressure type splicing devices as manufactured by 3M Company, Buchanan, Panduit, or approved equal.
2. Make splices and taps of conductors #8 AWG or larger and all splices in motor terminal boxes using compression connectors requiring the use of compression tools for securing the conductors in the connectors. Termination of conductors at all distribution equipment, except transformers, shall be made using mechanical lugs. Connectors shall be of high conductivity, corrosion-resistant material and have actual contact area that shall provide at least the current carrying capacity of the wire or cable. For conductors #1/0 and larger, connector lugs shall be of the two-hole type. Connector lugs shall be bolted to bussing using Belleville washers in combination with flat washers and nuts. Compression connectors shall be as manufactured by Thomas & Betts, Burndy, or approved equal.
3. Each conductor lug or bus connection shall be individually made with separate lug and/or bolt as required for the termination.
4. Provide insulated connectors for splices and taps with a self-fusing rubber insulating tape that is non-corrosive to the connector and the conductor. Insulation tape shall have a minimum of 350 volts per mil dielectric strength. Friction or vinyl tape shall be applied directly over rubber insulating tape equal to 3M Scotch 88 type.

W. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connector and terminals to comply with tightening torques specified in UL Std. 486A and B.

3.2 EQUIPMENT CONNECTIONS

A. Follow circuit numbers shown on Drawings in connecting circuits to panelboards. In the event that field observation shows that the indicated circuit numbers are not connected to the corresponding panel overcurrent device, make all corrections necessary. Each branch circuit homerun containing two or more circuits with a common neutral shall be connected to the circuit breaker or switch in a three or four-wire branch circuit panelboard so that no two of the circuits will be fed from the same phase.

B. Provide all wiring to and between motors, controllers, line voltage (120-600 volt) control devices, disconnect switches and other related electrical equipment, except where such

items are factory wired.

3.3 MAXIMUM BRANCH CIRCUIT LENGTHS

A. The following indicates maximum installed length a **20 ampere** circuit can have and still maintain an adequate voltage level at the last point of use. If the circuit length exceeds the length listed, use the next largest wire size. Multiple circuit runs in the same raceway shall have all conductors sized the same based on worst case circuit lengths.

Circuit Length (in feet)

Wire	**2 Wire**		**1 Phase**	
Size	**120V.**	**277V.**	**208V**	**480V**
12	**102**	**236**	**176**	**408**
10	**162**	**373**	**281**	**649**
8	**258**	**595**	**447**	**1032**

3.4 WIRE AND CABLE MARKING

A. Provide wire number labels (Brady or equal) at source, control, and device terminations corresponding to schematics or circuits used.

B. Color code cable with electrical friction tape at splices and terminations according to Paragraph 2.2E herein.

3.5 AS-BUILT DRAWINGS

A. Indicate all feeder sizes on the as-built drawings.

B. Indicate homerun junction box locations for all branch circuits.

3.6 FIELD QUALITY CONTROL

A. Prior to energization of circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled.

B. Prior to energization, test wires and cables for electrical continuity and for short-circuits.

C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION 16120

SECTION 16124 - MEDIUM VOLTAGE CABLE (600 - 35,000 VOLTS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Instructions to Bidders, and Division 1 Specification Sections and Instructions to Bidders apply to this Section.

B. Requirements of the following Division 16 Sections apply to this section:

1. Section 16010 - Basic Electrical Requirements.

1.2 SUMMARY

A. This section includes single and multiple conductor cables and splices, terminations, and accessories for 2,001- to 35,000-volt electrical distribution systems.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract, Division 1 Specification Sections and Section 16010.

B. Shop Drawings:

1. Product data on cables and cable accessories including descriptions and detailed specifications.
2. Shop drawings of splices and terminations.
3. Installer certificates signed by manufacturer of cable splicing and terminating products that Installers comply with training requirements specified under "Quality Assurance."
4. Installer certificates signed by Contractor that Installers of cable splices and terminations meet the experience qualifications specified under "Quality Assurance."
5. Product Test Reports: Certified reports of manufacturers factory production and final tests indicating compliance of cable and accessories with referenced standards.
6. Report of Field Tests: Certified copies of field test records.
7. Samples: 16 inches long of each type of cable specified.

C. Field Testing Data.

D. Operation and Maintenance Data:

1. Maintenance data for cables and accessories for inclusion in Operation and Maintenance manual specified in Division 1 and in Division 16 Section 16010 - Basic Electrical Requirements. In addition to the requirements specified there, include:

   a. Manufacturer's written instructions for periodic tests of cables in service.
   b. Operating instructions for fault indicators and separable insulated connectors and their accessories.

E. Record Documents.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer of medium voltage electrical cable to perform the installation specified in this section. In addition, for the specific work of cable splicing and terminating, engage Installers who are experienced in cable splices for the specific types of cable and cable accessories specified in this Section. Refer to Division 1 Section "Definitions and Standards" for definition of experienced Installer.

B. Field Testing Organization Qualifications: To qualify for acceptance, an independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.

C. Electrical Component Standard: Components and installation shall comply with NFPA 70 -National Electrical Code.

D. IEEE Compliance: Comply with applicable IEEE standards including C2 - National Electrical Safety Code.

E. UL Compliance: Cables and components shall be listed and labeled by UL.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver medium voltage cable on factory reels conforming to NEMA Standard WC 26, "Wire and Cable Packaging."

B. Store cables on reels on elevated platforms in a clean, dry location.

1.6 WARRANTY

A. Special Project Warranty: Submit a written warranty, mutually executed by manufacturer and the principal Installer, agreeing to repair or replace medium voltage cables, splices, and terminations that fail in materials or workmanship within the special project warranty period specified below. This warranty shall be in addition to, and not a limitation of, other rights and remedies the Owner may have against the Contractor under the Contract Documents.

1. Special Project Warranty Period: 2 years beginning on the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Cable:

(1) The Okonite Co.
(2) Rome Cable Corporation
(3) The Kerite Co

b. Cable Splicing and Terminating Products and Accessories:

(1) FL Industries, Inc.
(2) Electrical Products Division 3M.
(3) G&W Electric Co.
(4) The Kerite Co.
(5) M.P. Husky Corp.
(6) Raychem Corp.
(7) RTE Components.

2.2 MEDIUM VOLTAGE CABLE

A. General: Cable shall be of the single conductor types, with types and sizes as indicated, and conforming to UL Standard 1072 "Medium Voltage Power Cables."

B. Cable shall be ethylene propylene rubber (EPR) insulated and shall conform to NEMA Standard WC 8 (ICEA S-68-516) "Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy."

C. Conductors: Class B stranded, annealed copper.

D. Cable Jacket: Sunlight-resistant PVC.

E. Metallic Shielding: Copper shielding tape, helically applied over semiconducting insulation shield.

F. Cable Voltage Rating: 15 kV phase to phase.

G. Insulation Thickness: Corresponding to 133 percent insulation level in accordance with the referenced standard.

2.3 SPLICING AND TERMINATING PRODUCTS

A. General: Comply with the following standards:

1. IEEE 48: IEEE Standard Test Procedures and Requirements For High-Voltage Alternating Current Cable Terminations.
2. IEEE 400: Guide For Making High-Direct-Voltage Tests on Power Cable Systems in the Field.
3. IEEE 404: Standard For Power Cable Joints.
4. IEEE 592: Standard For Exposed Semiconducting Shields on Premolded High-Voltage Cable Joints and Separable Insulated Connectors.
5. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
6. UL 486B: Wire Connectors and Soldering Lugs for Use with Aluminum Conductors.

B. Types: Compatible with the cable materials.

C. Connectors: Compression type as recommended by cable or splicing kit manufacturer for the application.

D. Splicing and Terminating Kits: As recommended by the manufacturer in writing for the specific sizes, ratings, applications and configurations of cable conductor, splices, and terminations specified. As a minimum requirement, all kits shall be for waterproof splices and terminations. Kits shall contain all components required for a complete splice or termination including detailed instructions and shall be the product of a single manufacturer. Completed splices and terminations shall provide insulation equivalent to the insulation class of the cable it connects.

E. Conductor Terminations, General: Comply with Class 1, 2, or 3 of IEEE Standard 48, as indicated. Insulation class shall be equivalent to that of the cable upon which they are installed. Terminations for shielded cables shall include a shield grounding strap. Class 2 terminations and nonshielded cable terminations shall include an effective moisture seal for the end of the insulation whether or not this item is included in termination kits. Seal shall

be silicone rubber tape, cold shrink rubber sleeve, or heat shrink plastic sleeve as recommended by the kit manufacturer. Termination kits shall be performance tested for compliance with IEEE Standard 48 and shall be of the following types:

1. Class 1 Termination for Shielded Cable: Modular type, furnished as a kit, with stress relief tube, multiple molded silicone rubber insulator modules, shield ground strap, and compression-type connector.
2. Class 1 Termination for Shielded Cable: Heat shrinkable type with heat shrinkable inner stress control and outer nontracking tubes, multiple molded nontracking skirt modules, and compression-type connector.
3. Class 1 Termination for Shielded Cable: Modular type, furnished as a kit, with stress-relieving shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap compression-type connector.

F. Separable Insulated Connectors: Modular system, complying with IEEE Standard 386, "Separable Insulated Connectors For Power Distribution Systems Above 600V." System shall consist of disconnecting, single-pole, cable terminators and matching stationary, plug-in, dead-front terminals. System components shall be designed for the system voltage and for sealing against moisture and shall conform to the following:

1. Cable Terminations At Equipment (such as transformers or switchgear): Elbow-type terminators that mate with bushing terminals in the equipment.
2. Dead-Break Cable Terminators: Elbow-type unit with 600-ampere continuous current rating, designed for deenergized disconnecting and connecting. Each terminator shall be coordinated with insulation diameter and conductor size and material of cable being terminated. Terminator body shall have capacitively coupled test point.
3. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Terminal junctions shall have two, three, or four terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals. Terminal junctions shall have grounding lug and manufacturer's standard accessory stands and stainless steel mounting brackets and attaching hardware.
4. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
5. Portable Feed-Through Accessory: Two terminal dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
6. Grounding kit shall include jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.

7. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators shall be suitable for fully insulated isolation of energized cable elbow terminator.

2.4 ARC-PROOFING MATERIALS

A. Tape for first course on metal objects shall be 10-mil-thick, corrosion-protective, moisture-resistant PVC pipe-wrapping tape.

B. Arc-proofing tape shall consist of a UL-listed fireproofing tape. Tape shall be flexible, conformable, intumescent to 0.3-inches thick, and compatible with the cable jacket on which used. Tape shall be self-extinguishing and shall not support combustion.

C. Glass cloth tape shall be pressure-sensitive adhesive type, 1/2-inch wide.

2.5 FAULT INDICATORS

A. Indicators: Manual reset, fault indicator, arranged to clamp to cable sheath and provide a display after the cable has faulted. Instrument shall be immune to heat, moisture, and corrosive conditions and shall be recommended by the manufacturer for the installation conditions. Indicators shall have current trip ratings and quantities as indicated.

B. Resetting Tool: Designed for use with fault indicators. Furnish a moisture-resistant storage carrying case.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine installation locations for cleanliness and conditions affecting performance of cable. Do not proceed with cable installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. General: Install cable accessory items in accordance with manufacturer's written instructions and as indicated.

3.3 INSTALLATION OF CABLES

A. Install direct buried cable on a leveled and tamped 3-inch bed of clean sand at bottom of trench. Install "buried cable" warning tape 12 inches above cable. Separate cables crossing other cables or piping from those items by a minimum of 4 inches of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

3.4 INSTALLATION OF SPLICES

A. Install splices at pull points and elsewhere as indicated using standard kit. Conform to kit manufacturer's written instructions.

3.5 INSTALLATION OF CABLE ACCESSORIES

A. Arc-Proofing: Arc-proof medium voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials except where indicated. Apply as recommended by the manufacturer of the arc-proofing tape and the following:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil-pipe wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with the coated side toward the cable.
5. Band the arc-proofing tape with 1-inch-wide banks of half-lapped adhesive glass-cloth tape 2 inches on center.

B. Fault Indicators: Install fault indicators on each phase at the source end.

3.6 GROUNDING

A. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated connector fittings, and hardware in accordance with manufacturer's written instructions.

3.7 IDENTIFICATION

A. Identify cable in accordance with NEC..

3.8 FIELD QUALITY CONTROL

A. General: Comply with applicable standards of The International Electrical Testing Association (INETA) including Standard ATS - Acceptance Testing Specifications For Electrical Power Distribution Equipment and Systems.

B. Preparation: Perform the following preparations in advance of independent tests:

1. Test cables' insulation resistance.
2. Test circuits' continuity.

   a. Furnish a set of Contract Documents and manufacturer's recommendations to test organization.

3. Make power available at test locations.

C. Schedule tests and notify Architect at least one week in advance of schedule for test commencement.

D. Test procedure shall conform to the following:

1. Independent Testing Organization: Arrange and pay for the services of an independent electrical testing organization to perform tests on medium voltage cable.
2. Test Objectives: To assure cable installation is operational within industry and manufacturer's tolerances, is installed in accordance with Contract Documents, and is suitable for energizing.
3. Procedures: Comply with the INETA standard and IEEE 400. Upon satisfactory completion of tests, attach a label to tested components.

E. Tests shall include high-potential test of cable and accessories and such tests and examinations required to achieve specified objectives (See Appendix “A”). Where new cables are spliced to existing cables, the high-potential test shall be performed on the new cable prior to splicing. After test results for new cables are approved and splice is made, an insulation resistance test and continuity test is to be conducted on the length of cable including the splice with the existing cables being tested to the nearest disconnect point.

F. Reports: The testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit written reports to the Architect and Division 16.

APPENDIX "A"

REPORTING FORM - DC PROOF TESTING

TESTING COMPANY NAME _____

CUSTOMER _____

LOCATION _____

DATE OF TEST _____ TESTER'S NAME _____

HUMIDITY _____ % TEMPERATURE _____

WEATHER: CLOUDY _____ RAIN _____ SNOW _____ FOG _____ SUNNY

PHASE IDENTIFICATION				CABLE MANUFACTURER:
KV TEST VOLTAGE				CABLE RATED VOLTAGE:
MICROAMPERES	:A	:A	:A	OPERATING VOLTAGE:
TEST SET LEAKAGE				CONDUCTOR SIZE:
15 seconds				TYPE OF INSULATION:
30 seconds				NUMBER OF CONDUCTORS:
45 seconds				LENGTH:
1 minute				AGE:
2 minute				TYPE OF JACKET:
3 minute				SEPARATE NEUTRAL:
4 minute				OR
5 minute				CONCENTRIC NEUTRAL WIRES:
6 minute				TYPE OF TERMINATIONS AT TEST END: _____ _____

				_____ _____
7 minute				
8 minute				
9 minute				TYPE OF TERMINATIONS AT OPPOSITE END:_____ _____ _____ _____ _____ _____ _____
10 minute				
11 minute				
12 minute				
13 minute				REMARKS:_____ _____ _____ _____ _____
14 minute				
15 minute				

END OF SECTION 16124

SECTION 16143 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wall switches.

B. Receptacles.

C. Device plates and box covers.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Description: NEMA WD 1, general-duty, AC only general-use snap switch.

B. Voltage Rating: Dual 120-277 volts, AC.

C. Current Rating: 20 amperes.

2.2 RECEPTACLES

A. Description: NEMA WD 1: general-duty general-use receptacle.

B. Configuration: NEMA WD 6; type as specified and indicated.

C. Convenience Receptacle: Type 5-20.

2.3 WALL PLATES

A. Decorative Cover Plate: Stainless Steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install receptacles with grounding pole on bottom unless required other wise by the Authority having jurisdiction.

B. Connect wiring device grounding terminal to outlet box with bonding jumper.

END OF SECTION 16143

SECTION 16470 - PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION: This section includes the furnishing, installation and connection of the panelboards.

PART 2 - PRODUCTS

2.1 PANELBOARDS

A. Manufacturers: The panelboards shall be manufactured by Square D, Cutler-Hammer or General Electric.

B. Panelboards shall have the following features:

1. Dead-front type mounted in enclosing code gauge, sheet steel cabinets with trim and doors. Doors shall be equipped with flush hinges, flush chromium plated bronze lock and latch. Locks shall be keyed alike and two keys furnished with each panel lock. Busbars shall be copper, 98% conductivity.

2. 50% copper ground bar with sufficient terminals for all grounding wires.

3. Where designated on panel schedule as “space”, include all necessary bussing, device support and connections. Provide blank cover for each space.

4. Provide a directory card, metal holder, and transparent cover. Permanently mount holders on inside of doors.

2.4 MOLDED CASE CIRCUIT BREAKERS FOR PANELBOARDS

A. Circuit breakers in panelboards shall be bolt on type.

1. Molded case circuit breakers for lighting and appliance branch circuit panelboards shall have interrupting rating as indicated on the drawings.

2. For circuit breakers being added to existing panelboards, match the breaker type & interrupting Rating with those in existing panelboards. Modify the panel directory.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate panelboards so that future conduits can be conveniently connected.

B. Paint the panelboard name, system voltage, and feeder sizes as shown on the riser diagram on the inside and outside of the cover of the cabinet door. Use one inch block letters.

C. Install a typewritten schedule of circuits in each panelboard.

D. Mount the panelboard so that the maximum height of circuit breaker above finished floor shall not exceed 78 inches. For panelboards which are too high, mounted panelboard so that the bottom of the cabinets will not be less than six inches above the finished floor.

E. In finished spaces, paint the exposed surfaces of the trims, doors, and boxes with finishes to match surrounding surfaces after the panelboards have been installed.

F. Circuit numbers indicated on the drawings are shown for the purpose of clarifying the grouping of outlets. The actual number assigned to the circuit in the panelboard shall suit the bussing and branch circuiting to the panel.

END OF SECTION 16470

SECTION 16475 - PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Instructions to Bidders, and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 16 sections apply to this Section:

1. Section 16010 - Basic Electrical Requirements.
2. Section 16050 - Basic Electrical Materials and Methods.

1.2 SUMMARY

A. This Section includes circuit breakers, fusible disconnect devices and fuses rated 600 volts and less. Application, installation, and other related requirements for overcurrent protective device installations in other distribution equipment is specified in other Division 16 sections.

1.3 DEFINITIONS

A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

B. Ampere-Squared-Seconds: An expression of available thermal energy resulting from current flow. With regard to current-limiting fuses and circuit breakers, the ampere-squared-seconds during fault current interruption represents the energy allowed to flow before the fuse or breaker interrupts the fault current within its current limiting range.

1.4 LEGEND

A. AIC = Amperes interrupting capacity (K = 1000)

B. Non = Non-interchangeable

C. Chg = Interchangeable

D. HID = Switching duty rated for HID or fluorescent fixtures.

E. SWD = Switching duty rated at 20 ampere rating for fluorescent fixtures.

F. GFI = Ground fault interrupting

G. BIL = Basic impulse level (K = 1000)

1.5 COMPATIBILITY

A. All protective devices in new assemblies shall be of the same manufacture except for special applications of proprietary types to maximize single-source responsibility.

B. Series ratings of OCPDs are not acceptable.

1.6 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract, Division 1 Specification Sections and Section 16010.

B. Shop Drawings:

1. Product data for fuses, fusible switches, circuit breakers, and OCPD accessories specified in this Section, including descriptive data and time-current curves for all protective devices and let-through current curves for those with current limiting characteristics. Include coordination charts and tables and related data.

C. Field Testing Data.

D. Operation and Maintenance Manuals.

1. Include final fuse type and ratings as well as served equipment list for all installations.

2. Include "as-designed" and "as-left" OCPD adjustable settings list for all installations.

3. Include key interlock sequence of operation per assembly.

E. Record Documents.

1.7 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

C. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.

D. Series ratings of OCPDs is not acceptable.

1.8 REFERENCES AND STANDARDS

A. Enclosures:

1. NEMA 250-85 - Enclosures for Electrical Equipment (1,000 Volts, maximum).

B. Molded Case and Insulated Case Circuit Breakers:

1. UL 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures.
2. NEMA AB1 - Molded Case Circuit Breakers.

C. Disconnect Switches

1. UL 98-87 - Enclosed and Dead Front Switches.
2. NEMA K -85 - Enclosed Switches.
3. UL 977-84 - Fused Power Circuit Devices.

PART 2 - PRODUCTS

2.1 THERMAL-MAGNETIC MOLDED CASE CIRCUIT BREAKERS

A. Make - Cutler-Hammer, General Electric, Square D.

B. Construction

1. Tripping mechanisms - Inverse time delay thermal element for long-time overload tripping and an instantaneous magnetic trip element set to operate at 7 to 10 times the long-time trip setting for high fault current tripping in each phase. Common trip for multiple breakers without the use of handle ties. Trip-free over center quick-make, quick-break switching mechanism shall provide distinctive handle positions to self-indicate automatic tripping.
2. Enclosure - Bakelite, epoxy, glass-fibered reinforced polyester or similar material required to obtain interrupting rating.
3. Mounting - Plug-in for assembly rated 14,000 amperes interrupting capacity or below; bolt-in otherwise. Rating labels shall be visible when breaker is installed.
4. Terminal lugs - Suitable for quantity of wire or bus to be attached; mechanical type for copper wire, compression type for aluminum wire, and bolted for bus connections.

C. Ratings:

1. Trip – As scheduled.
2. Frame – Provide as scheduled as minimum requirement.
3. AIC – Provide as scheduled as minimum requirement.

D. Special features - Interchangeable trip settings, shunt trip, undervoltage trip, bell alarm, auxiliary switch, motor operator, etc., as shown on Drawings.

2.2 INSULATED CASE CIRCUIT BREAKERS

A. Make – Cutler Hammer SPB series, General Electric, JP/TC or THP/THC series and Square-D SE series.

B. Construction

1. Tripping mechanisms - Solid-state tripping elements with associated current monitors and two step stored energy tripping with manual charging mechanism for closing springs which automatically charge the opening springs during operation. Closing shall be within 5 cycles for generator synchronization. Manual tripping shall be accomplished by a mechanical push-button. Long-time trip settings shall be interchangeable with removable rating plugs.

2. Sensors - Static sensors in each pole shall have adjustments for:
   a. Long-time pick-up (5 points minimum).
   b. Long-time delay (3 bands minimum).
   c. Short-time pick-up (5 points minimum).
   d. Short-time delay (3 bands minimum).
   e. Instantaneous pick-up (6 points minimum).
3. Indicators - Shall show status and conditions for:
   a. Breaker position.
   b. Stored energy charging system status.
   c. Instantaneous trip.
   d. Overload trip.

4. Ground fault protection tripping - Shall have necessary internal and/or external sensors and feature an adjustable pick-up (3 points minimum) and time delay (3 bands minimum) range from 0 to 18 cycles. Provide trip indictor and test panel.

5. Enclosures
   a. Encased - Glass-reinforced thermostat polyester.
   b. Metal enclosed with arc-extinguishing chutes.

6. Mounting - Fixed or drawout as shown on Drawings. Drawout breakers shall be mounted on a rigid, self-aligning mechanism with distinct connected, test,

disconnected and remove positions. Provide interlocks to insure breaker is open before it can be moved to any position. Include an interlock to discharge the stored energy spring before breaker can be withdrawn from cell. In the test and connected positions, provide a positive ground contact between breaker element and the structure. Furnish padlocking provisions for up to 3 padlocks when the breaker is in the open position which positively prevents unauthorized closing of the breaker contacts.

7. Terminal lugs - Suitable for quantity of wire or bus to be attached; mechanical type for copper wire, compression type for aluminum wire, and bolted for bus connection.

8. Contacts and front entrance cover indicating lights - Suitable for "Breaker Open" and "Breaker Closed" for main and bus tie breakers, and for other indicated breakers.

C. Ratings
1. Trip – As scheduled.
2. Frame – Provide as scheduled as minimum requirement.
3. AIC – Provide as scheduled as minimum requirement.

2.3 SEPARATELY ENCLOSED CIRCUIT BREAKERS

A. Enclosure
1. Flush or surface as shown on Drawings.
2. Type shall suit area per NEMA requirements.
3. Ground wire lug of suitable size shall be brazed to the enclosure. Neutral bar on four wire systems shall be ungrounded.
4. Nameplate centered on front shall identify load served.

B. Breaker characteristics shall be as previously specified.

2.4 DISCONNECT SWITCHES

A. General
1. 120 volt disconnect switches shall be wiring device switches.
2. Other disconnect switching shall be as specified below.

B. Make - Cutler-Hammer, General Electric, Square D.

C. Construction
1. Heavy duty type, fused and/or non-fusible as shown on Drawings.
2. Interior construction - Switch blades fully visible in the off position when the

enclosure door is open. Fuseholders for specified fuse, rejection type.

3. Switch mechanism - Quick make, quick break with positive interlock to prevent opening of enclosure door when operating handle is in the on position and to prevent closing of the switch mechanism with the door open. Operating handle shall be an integral part of enclosure base, have provisions for three padlocks in the off position, and the means to indicate whether the switch is on or off by its position.
4. Terminal Lugs - Suitable for quantity of wire to be attached, front removable with terminal shields; mechanical type for copper wire, compression type for aluminum wire.

D. Ratings
1. Amperes - 30-1200
2. Voltage - 240 or 600
3. Poles - 2, 3 or 6
4. AIC - Match fuse or upstream protective device
5. Horsepower rated - 30 - 600 amps

E. Enclosure
1. Surface mounted type.
2. Type shall suit area per NEMA requirements.
3. Ground wire lug of suitable size shall be brazed to the enclosure. Neutral bar on four wire systems shal be ungrounded.
4. Nameplates on front shall identify load service as well as proper fuse application warning.

F. Label each safety switch with the following legend in capital lettering at least 3/8 inch high: "DANGER, DO NOT START OR STOP MOTOR WITH THIS SWITCH. USE FOR ISOLATION ONLY."

2.5 FUSEHOLDERS

A. Provide fuseholders to accommodate the fuses specified. Coordinate installation with assembly manufacturers as applicable.

1. Terminal lugs - Suitable for quantity of wire or bus to be attached; mechanical type for copper wire, compression type for aluminum wire, and bolted for bus connection.

2.6 ACCESSORIES

A. Provide breaker accessories for general operation and maintenance of specified breakers.

Include items listed below and items recommended by manufacturer:

1. Three (3) spare current limiting plugs for each rating specified.
2. Special adjustment tools.

B. Provide fuse accessories for general operation and maintenance of specified fuses. Include items listed below and items recommended by manufacturer.

1. Fuse pullers.

C. Provide quantities of circuit protective accessories in locations necessary for effective general operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install circuit protective devices in assemblies at or above the minimum interrupting rating and frame size shown on Drawings. Circuit breaker frame size shall be the largest ampere rating if not specified in the rating schedules.

B. Install separately enclosed circuit breakers and disconnect switches at five feet above floor unless otherwise noted. Support independent of stud partitions.

C. Install fused disconnect switches as shown on Drawings and Schedules, complete with fuses recommended by the manufacturer of the equipment served. Division 16 shall be reproducible to ensure proper AIC ratings for protection of the switch and equipment. Submit final fuse ratings as part of O&M Manual submission. Series ratings of OCPD are not acceptable.

D. Install distribution equipment circuit protective devices at factory.

E. Coordinate factory or field installation of key interlocks and associated sequence of operation nameplate.

3.2 IDENTIFICATION

A. Identify components.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between OCPDs and control/indication devices as specified in Section 16120 - Low Voltage Wires and Cables for hard wired connections.

3.4 CONNECTIONS

A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

3.5 GROUNDING

A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.6 FIELD QUALITY CONTROL

A. Testing Organization: Arrange and pay for the services of an electrical testing organization to perform tests and observations on OCPDs.

B. Reports: Prepare written reports certified by testing organization on tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include complete records of repairs and adjustments made.

C. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

D. Schedule visual and mechanical inspections and electrical tests with at least one week's advance notification.

E. Pretesting: Upon completing installation of the system, perform the following preparations for tests:

1. Make insulation resistance tests of OCPD buses, components, and connecting supply, feeder, and control circuits.
2. Make continuity tests of circuits.
3. Provide set of Contract Documents to test personnel. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
4. Provide manufacturer's instructions for installation and testing of OCPDs to test personnel.

F. Visual and mechanical inspection: Include the following inspections and related work.

1. Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters. Where discrepancies are found, test organization shall recommend final

protective device rating and settings. Use accepted revised ratings or settings to make the final system adjustments.

2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
3. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
4. Check tightness of electrical connections of OCPDs with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Clean OCPDs using manufacturer's approved methods and materials.
6. Verify installation of proper fuse types and ratings in fusible OCPDs.

G. Electrical Tests: Include the following items performed in accordance with manufacturer's instructions:

1. Insulation resistance test of OCPD conducting parts. Insulation resistance less than 100 megohms is not acceptable.

2. Insulation resistance test of fused power circuit devices and insulated-case, power air, and molded-case circuit breakers over 600-ampere frame size at 1000 V D.C. for one minute from pole to pole and from each pole to ground with breaker s closed and across open contacts of each phase. Insulation resistance less than 100 megohms is not acceptable.
3. Use primary current injection to check performance characteristics of trip units of insulated-case circuit breakers and molded-case breakers over 600-ampere frame size. Trip characteristics not falling within manufacturer's published time-current characteristic tolerance bands when adjusted to approved parameters are not acceptable. Perform the following tests:
   a. Determine minimum pickup current acceptable per manufacturer's instructions.
   b. Determine long-time delay at 300 percent pickup current.
   c. Determine short-time-pickup current and corresponding delay time.
   d. Determine ground-fault current pickup and corresponding delay time.
   e. Determine instantaneous pickup current value.
   f. Verify trip unit reset characteristics for insulated-case circuit breakers.
   g. Make adjustments for final settings of adjustable-trip devices.
   h. Activate auxiliary protective devices such as ground fault or undervoltage relays, to verify operation of shunt-trip devices.
   i. Retest: Correct deficiencies identified by tests and observations and provide retesting of OCPDs by testing organization. Verify by the system tests that specified requirements are met.

3.7 CLEANING

A. Upon completion of installation, inspect OCPDs. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.8 DEMONSTRATION

A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate OCPDs and train Owner's maintenance personnel.

B. Conduct a minimum of two hours of training in operation and maintenance as specified under "Instructions to Owner Employees" in the "Project Closeout" Section of these specifications.

C. Schedule training with at least seven days' advance notification.

3.9 INFRARED SCANNING

A. Infrared Scanning: After Substantial Completion, but not more than 2 months after Final Acceptance, perform an infrared scan of OCPDs including their line and load connections, fuses, and fuse clips. Also scan OCPD contact structures where accessible to a portable scanner. Include individual OCPDs and those installed in switchboards, panelboards, and motor control centers.

B. Follow-up Infrared Scanning: Perform two additional follow-up infrared scans of the same devices: One four months after Substantial Completion, and one 11 months after Substantial Completion.

C. Instrument: Use an infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

D. Record of Infrared Scanning: Prepare a certified report identifying all OCPDs checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and rescanning observations after remedial action.

END OF SECTION 16475

SECTION 16481 - MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this Section.

B. Requirements of the following Sections apply to this Section:

1. Section 16010 - Basic Electrical Requirements.
2. Section 16050 - Basic Electrical Materials and Methods.
3. Section 16475 - Protective Devices.

1.2 SUMMARY

A. This Section includes motor control devices rated 600 V and below that are not supplied with equipment furnished by other Divisions of this Specification.

1.3 DEFINITIONS

A. Motor Controller: A device that controls, protects, and energizes an electric motor, and where required, controls its speed or the torque or power delivered by it.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract, Division 1 Specification Sections and Section 16010.

B. Shop Drawings:

1. Product data for products specified in this Section. Include dimensions, ratings, and data of features and components.
2. Load Current and Overload Relay Heater List: Compiled by Division 16 after motors have been installed. Arrange to demonstrate selection of heaters to suit actual motor nameplate full load currents and associated power factor correction.
3. Provide control circuit and wiring diagrams.
4. Provide bill of material listing all controllers, sizes, and devices.
5. For combination starters, list fault current withstand and interrupting rating of the

assembly.

C. Field Testing Data:

1. Qualification data for field-testing organization certificates, signed by the Contractor, certifying that the organization complies with the requirements specified in "Quality Assurance" below. Include list of completed projects with project names, addresses, names of Architects and Owners, plus other information specified.
2. Certified reports of field tests and observations specified in "Field Quality Control" in this Section.

D. Operation and Maintenance Manuals

1. Maintenance data for products for inclusion in Operating and Maintenance Manual specified in Division 1 and in Section 16010 - Basic Electrical Requirements.

E. Record Documents

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide reduced-voltage controllers from manufacturers regularly engaged in the manufacture of equipment of the types and capacities indicated, with such products in satisfactory use in similar service for not less than 5 years. Manufacturer must also maintain, within 100 miles of the project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Components and Installation: NFPA 70 "National Electrical Code."

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.

D. NEMA Compliance: NEMA ICS 2, "Industrial Control Devices, Controllers and Assemblies."

E. UL Compliance: UL 508, "Electric Industrial Control Equipment."

F. Single-Source Responsibility: Obtain similar motor-control devices from a single manufacturer.

G. Assembly Selection: The Drawings indicate sizes, profiles, and dimensional requirements of assembly equipment. Equipment having equal performance characteristics and

complying with indicated maximum dimensions and profiles may be considered, provided deviations do not change the design concept intended performance, or code/future extension provision clearances. The burden of proof of equality is on the proposer a minimum of 10 days prior to bid.

1.6 COORDINATION

A. General: Coordinate features of controllers and control devices with pilot devices and control circuits provided under Division 15 Sections covering control systems.

1.7 EXTRA MATERIALS

A. Spare Fuses and Incandescent Indicating Lamps: Furnish one spare for every 5 installed units, but not less than one set of 3 of each kind.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. ABB Power Distribution, Inc.
2. Allen-Bradley Co.
3. Cutler-Hammer.
4. Eaton Corp./Cutler-Hammer Products
5. General Electric Co.
6. Siemens Energy & Automation, Inc.
7. Square D Co.

2.2 MOTOR CONTROLLERS, GENERAL

A. Controller shall be manual type for motors 1/3 HP and smaller and magnetic type for motors 1/2 HP and larger.

B. Coordinate the features of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, the duty cycle of the motor, drive, and load, and the pilot device, and control circuit affecting controller functions. Provide controllers that are horsepower rated to suit the motor controlled.

C. Contacts shall open each ungrounded connection to the motor.

D. Controller contacts shall be twin-break, silver-to-silver, renewable contacts with one set of contacts for each phase.

E. Overload Relays: Ambient-compensated type with inverse-time-current characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of the specific motor to which connected with appropriate adjustment for duty cycle.

F. Enclosures: For individually mounted motor controllers and control devices, comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)." Provide enclosures suitable for the environmental conditions at the controller location. Provide NEMA Type 1 enclosures except as otherwise indicated.

1. The coverplate shall have a lock-off tab for a padlock.

2.3 MANUAL FRACTIONAL HORSEPOWER MOTOR CONTROLLERS

A. Description: Quick-make, quick-break toggle action.

B. Single-phase motor control switches (thermal switches) for fractional horsepower motors. Single pole for 120 volt, two pole for 208 volt operation. Mount flush in finished areas and surface otherwise.

C. Trip-free, toggle operated with on-off-reset position clearly indicated with neon pilot light for run indication.

D. Thermal overload shall be ambient compensated, plug-in type element with heater rating clearly indicated. Provide one overload for single pole switch and two overloads for two pole switch.

E. Where the motor is interlocked and controlled by another device, the motor controller shall be marked "Hand-Off-Auto".

2.4 COMBINATION MAGNETIC MOTOR CONTROLLERS

A. Description: Provide full-voltage, nonreversing, across-the-line, magnetic controller, except where another type is indicated.

B. Control Circuit: 120 V. Provide control power transformer integral with controller where no other supply of 120 V control power to controller is indicated. Provide control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

C. Combination Controller: Switch type; fused or nonfused as indicated; quick-make, quick-break switch; factory assembled with controller, and arranged to disconnect it. For fused switches, provide rejection-type fuse clips and fuses rated as indicated. Switches and fuses are specified in Section 16475 Protective Devices. Interlock switch with unit cover or door.

D. Enclosure door shall be interlocked with the operating handle to prevent opening of doors with handle in the on position.

E. Shall be provided with the following pilot lights:

1. Green light to indicate motor running.
2. Red light to indicate motor off.

2.5 COMBINATION 2-SPEED MAGNETIC MOTOR CONTROLLERS

A. General: Match controller to motor type, application, and to number of speeds. Conform to Article "Magnetic Motor Controllers" above. Provide auxiliary devices as indicated herein and on Drawings. Provide all required relays factory installed in controller enclosure.

B. Combination starters shall be across-the line full voltage, non-reversing type with undervoltage release for 2 speed motors. Be factory assembled and include magnetic type controllers and motor circuit protector.

C. The controller shall serve the purpose of starting a 2-speed motor at the pre-selected speed and to provide complete overload, overcurrent, and undervoltage protection at each speed.

D. The 2-speed controller shall basically be an assembly of two magnetic across-the-line controllers, one for each motor speed, mechanically and electrically interlocked and wired for automatic control through a cover mounted control switch. Include single phase protection and voltage unbalance trip relays.

E. Controller shall be provided with the following pilot lights:

1. Green light to indicate motor high speed.
2. Amber light to indicate motor low speed.
3. Red light to indicate motor off.

F. Decelerating Relay: Provide selection of lower than current operating speed by pushbutton or pilot device as indicated with deceleration automatically timed through any intervening speeds.

2.6 REDUCED-VOLTAGE MOTOR CONTROLLERS

A. Star-Delta Magnetic Type: Closed transition with adjustable time delay.

B. Solid-State Type: Suitable for use with standard NEMA Design B, 3-phase induction motors, providing adjustable acceleration rate control using voltage or current ramp. Provide adjustable starting torque control with up to 500 percent current limitation for 20 seconds. Provide surge suppressor in solid-state power circuits to provide 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage. Provide snubbers to prevent malfunction due to system voltage transients. Provide overload protection for NEMA Class 10 or better. Provide LEDs to indicate motor and control status including control power available, controller on, overload trip, loss of phase, and shorted SCR.

2.7 AUXILIARY CONTROL DEVICES

A. General: Factory installed in controller enclosure except as otherwise indicated. Where separately mounted, provide NEMA 1 enclosure except as otherwise indicated.

B. Control devices such as pushbuttons and selector switches shall be heavy-duty, oil-tight, and be key operated or lockable where shown on Drawings.

C. Control selector switches shall be as indicated on Drawings and shall be one of the following:

1. Start-Stop
2. Hand-Off-Auto (H-O-A)

D. Provide each H-O-A switch with momentary stop and start push buttons located in the "H" leg to prevent accidental starting when the switch is turned to the "H" position.

E. Control devices shall be mounted in starter cover and be labeled with the motor or assembly which they serve.

F. Control functions shall assure proper fire alarm system overrides. If such overrides are through Division 15 hardware/software, Division 16 shall coordination per Section 16721 requirements.

G. Pilot lights shall be transformer type, heavy-duty, oil tight.

H. Provide 1 "NO" and 1 "NC" isolated auxiliary contacts in addition to the normal hold-in contact and auxiliary contacts required for interlocks and pilot lights.

I. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. General: Install independently mounted motor control devices in accordance with manufacturer's written instructions.

B. Coordinate motor control equipment with the motor being supplied. Refer to motor controller schedules on Drawings. Note that scheduled motor circuit protectors are based on continuous duty ratings.

C. Manufacturer's Field Services: Arrange and pay for the services of a factory-authorized service representative to inspect the field assembly and connection of components, and supervise the pretesting and adjustment of solid-state controllers.

D. Location: Locate controllers as indicated and within sight of motors controlled approximately where shown on Drawings.

E. Mounting: For control equipment surface mounted on walls, bolt units to wall or mount on light-weight structural steel channels bolted to the wall. For controllers not at walls, provide freestanding racks fabricated of structural steel members and light-weight slotted structural steel channels. Use feet consisting of 3/8-inch thick steel plates, 6 inches square, bolted to the floor. Use feet for welded attachment of 1-1/2-inch by 1-1/2-inch by 1/4-inch vertical angle posts not over three feet on center. Connect the posts with horizontal lightweight slotted steel channels and bolt the control equipment to the channels.

1. Individually mounted magnetic and manual controllers mounted in finished areas shall be flush. Flush coverplates shall be satin finish, stainless steel for manual starters or painted finish for magnetic controllers. Manufacturer's nameplates or holes resulting therefrom will not be permitted.

F. For magnetic controller/controllers, combination motor circuit protector type shall be used. If fuses are indicated, the motor circuit protector shall be equipped with current limiters.

G. Where interlocking or sequence starting of motors is specified by Division 15 or 16 or shown on Drawings, it shall be done such that when the circuit feeding a starter is open, no part of the controller/controllers shall be energized. Furnish any relays, auxiliary contacts or disconnect switches necessary to implement the indicated sequences and interlocks.

H. Provide permanent wiring diagrams as approved by the Architect showing all internal starter wiring within each motor controller/controllers compartment. Glued-on blueline prints are not acceptable. Also provide interlock wiring diagrams between controller/controllers

I. Overloads shall be of NEMA size required to match the specified motor nameplate.

J. Minimum controller/controllers size shall be NEMA 1.

K. Provide wiring from the starter to the motor. For 2-speed, 3-phase controller/controllers, provide three or six wires as required by the controller/controllers type.

3.2 IDENTIFICATION

A. Identify motor control components and control wiring.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between motor control devices and control/indicating devices as specified in Section 16120 - Low Voltage Wires and Cables for hard-wired connections.

B. Install wiring in enclosures neatly bundled, trained, and supported.

3.4 CONNECTIONS

A. Tighten connectors, terminals, bus joints, and mountings. Tighten field connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, comply with tightening torques specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Testing Organization: Arrange and pay for the services of an electrical testing organization to perform tests and observations on motor control devices.

B. Reports: Prepare written reports certified by testing organization of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made.

C. Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

D. Schedule visual and mechanical inspections and electrical tests with at least one week's advance notification.

E. Pretesting: On completing installation of the system, perform the following preparations for tests:

1. Make insulation resistance tests of conducting parts of motor control components; and of connecting supply, feeder, and control circuits. For devices containing solid-state components, use test equipment and methods recommended by the manufacturer.
2. Make continuity tests of circuits.
3. Provide set of Contract Documents to test personnel. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
4. Provide manufacturer's instructions for installation and testing of motor control devices to test personnel.

F. Visual and mechanical inspection: Include the following inspections and related work.

1. Motor-Control Device Ratings and Settings: Verify that ratings and settings as installed are appropriate for final loads and final system arrangement and parameters. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit the load current and overload relay heater list.
2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current project drawings.
3. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instructions.
4. Check tightness of electrical connections of devices with calibrated torque wrench. Use manufacturer's recommended torque values.
5. Clean devices using manufacturer's approved methods and materials.
6. Verify proper fuse types and ratings in fusible devices.

G. Electrical Tests: Perform the following in accordance with manufacturer's instructions:

1. Use primary current injection to check performance characteristics of motor-circuit protectors and for overload relays of controllers for motors 15 horsepower and larger. Trip characteristics not within manufacturer's published time-current tolerances are not acceptable.
2. Make adjustments for final settings of adjustable-trip devices.
3. Test auxiliary protective features such as loss of phase, phase unbalance and undervoltage to verify operation.
4. Check for improper voltages at terminals in controllers that have external control wiring when controller disconnect is opened. Any voltage over 30 V is unacceptable.

H. Correct deficiencies and retest motor control devices. Verify by the system tests that

specified requirements are met.

3.6 CLEANING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marks of finish to match original finish. Clean devices internally using methods and materials as recommended by manufacturer.

3.7 DEMONSTRATION

A. Training: Arrange and pay for the services of a factory-authorized service representative to demonstrate solid-state and variable-speed controllers and train Owner's maintenance personnel.

B. Conduct a minimum of 4 hours of training in operation and maintenance as specified under "Instructions to Owner's Employees" in Division 1 Section "Project Closeout." Include training relating to equipment operation and maintenance procedures.

C. Schedule training with at least seven days' advance notification.

END OF SECTION 16481