TECHNICAL SPECIFICATIONS

REHABILITATION OF
UNIVERSIDAD CENTRAL DEL CARIBE - UCC,
MAIN BUILDING DAMAGE # 305240

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SECTION 01050: FIELD ENGINEERING

1. SCOPE

   A. Work included: Provide such field engineering services as are required for proper completion of the Work including, but not necessarily limited to:
      1. Establishing and maintaining lines and levels;
      2. Structural design of shores, forms and similar items provided by the Contractor as part of his means and methods of construction.

2. QUALITY ASSURANCE

   A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

3. SUBMITTALS

   A. Upon request of the Architect, submit:
      1. Data demonstrating qualifications of persons proposed to be engaged for field engineering services.
      2. Documentation verifying accuracy of field engineering work.
      3. Certification, signed by the Contractor's retained field engineer, certifying that elevations and locations of improvements are in conformance or nonconformance with requirements of the Contract Documents.

4. PROCEDURES

   A. In addition to procedures directed by the Contractor for proper performance of the Contractor's responsibilities:
      1. Locate and protect control points before starting work on the site.
      2. Preserve permanent reference points during progress of the Work.
      3. Do not change or relocate reference points or items of the work without specific approval from the Architect.
      4. Promptly advise the Architect when a reference point is lost or destroyed, or requires relocation because of other changes in the Work.
         a) Upon direction of the Architect, require the field engineer to replace reference stakes or markers.
         b) Locate such replacements according to the original survey control

SECTION 01 10 00

SUMMARY OF WORK

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Division 010000 – General Requirements
B. Division 072200 – Roof Insulation
C. Division 072713 – Modified Bituminous Sheet Vapor Retarders
D. Division 075216 – Styrene-Butadiene-Styrene (SBS) Modified Bitumen Membrane Roofing
E. Division 076200 – Sheet Metal Flashing and Trim

1.02 DESCRIPTION

A. The Work includes the provision of all labor, material, equipment, management, coordination, supervision, and administration to complete the Work as outlined.

1.03 WORK COVERED

A. ROOFING:
   1. STYRENE-BUTADIENE-STYREEN (SBS) MODIFIED BITIMEN MEMBRANE ROOFING:
      a. Preparation of existing concrete deck, and all flashing substrates.
      b. SBS-modified bitumen vapor retarder (tear off membrane protection).
      c. [Insulation][asphaltic cover board],[mechanically fastened][adhered].
      d. SBS-modified bitumen base ply(s), [heat-welded][cold adhesive-applied][self-adhesive][asphalt-applied][mechanically fastened].
      e. SBS-modified bitumen cap sheet, [heat-welded][cold adhesive-applied][self-adhesive].
      f. SBS-modified bitumen membrane flashings.
      g. Liquid-applied PMMA reinforced flashings.

END OF SECTION

SECTION 01200: PROJECT MEETINGS

1. DESCRIPTION

   A. Work Included:
      1. To enable orderly review of progress during construction and to provide for systematic discussion of problems, the Architect will conduct project meetings throughout the construction period.
      2. In general, project meetings will be held weekly at the job site in accordance with a mutually acceptable schedule.
      3. The purpose of the project meetings is the analysis of problems that might arise between the Owner and the Contractor relative to execution of the Work.

   B. Related work described elsewhere:
      1. The Contractor's relation with his subcontractors and materials suppliers, and discussions relative thereto, are the Contractor's responsibility as described in the General Conditions and are not part of project meetings content.

2. QUALITY ASSURANCE

   A. Persons designated by the Contractor to attend and participate in project meetings shall have all required authority to commit the Contractor to solutions as agreed upon in the project meetings.

3. SUBMITTALS

   A. Agenda items:
      1. To the maximum extent possible, advise the Inspector at least 24 hours in advance of the project meeting regarding all items to be added to the agenda. The Inspector will prepare the meeting’s agenda.

   B. Minutes:
      1. The Inspector will compile minutes of each project meeting and will distribute copies to the Owner, Architect and the Contractor. The Contractor shall make and distribute such other copies as he wishes.

4. MEETING SCHEDULE

   A. Coordinate with the Architect as required to establish a mutually acceptable schedule for weekly project meetings.

5. MEETING LOCATION

   A. To the maximum extent practicable, project meetings shall be held at the job site. Provide adequate and facility

including table, chairs, and lighting for the meetings.

6. ATTENDANCE

A. To the maximum extent practicable, assign the same person or persons to represent the Contractor and Subcontractors at project meetings throughout the construction period. Subcontractors of the electrical and mechanical work shall attend all those project meetings. Other subcontractors and suppliers shall attend only meetings in which their aspects of the Work are involved.

SECTION 01340: SUBMITTALS, AN EQUAL AND SUBSTITUTIONS

1. DESCRIPTION

   A. Work included:
      1. Wherever possible throughout the Contract Documents, the minimum acceptable quality of workmanship and materials has been defined either by manufacturer's name and catalog number or by the reference to recognized industry standards.
      2. Although the construction plans specify materials, equipment, products, and systems by brands and models, these may be replaced by equal or similar items whose characteristics and properties meet those of the specified items as stated in Article 7 of this Specification Section.

   B. Related work described elsewhere
      1. Contractual requirement for submittals: General Conditions and Special Conditions.
      2. Individual submittals required: Pertinent Sections of these Specifications.

2. PRODUCT HANDLING

   A. Make all submittals of Shop Drawings, Samples, requests for substitution and other similar items, in strict accordance with the provisions of this Section of these Specifications.

   B. Prior to each submittal, carefully review and coordinate all aspects of each item being submitted. Verify that each item and the submittal for it conform in all respects with the specified requirements. By affixing the Contractor's signature to each submittal, certify that this coordination has been performed.

3. SHOP DRAWINGS

   A. Scale required
      1. Unless otherwise specifically directed by the Architect, make all Shop Drawings accurately to a scale sufficiently large to show all pertinent features of the item and its method of connection to the Work.

   B. Type of prints required
      1. Submit all Shop Drawings in the form of blue line or black line print and one reproducible mylard or sepia of each sheet.

4. MANUFACTURER'S LITERATURE

   A. General
      1. Where contents of submitted literature from

manufacturers includes data not pertinent to the submittal, clearly indicate which portion of the contents is being submitted for the Architect's review.

B. Number of copies required
   1. Submit the number of copies which are required to be returned plus three copies which will be retained by the Architect.

5. SAMPLES

A. Accuracy of Sample
   1. Unless otherwise specifically directed by the Architect all Samples shall be of the precise article proposed to be furnished.

B. Number of Samples required
   1. Submit all Samples in the quantity which is required to be returned plus two which will be retained by the Architect.

6. COLORS

A. General
   1. Unless the precise color and pattern is specifically described in the Contract Documents, whenever a choice of color or pattern is available in a specified product, submit accurate color charts and pattern charts to the Architect for his review and selection.

B. Comparative analysis
   1. Unless all available colors and patterns have identical costs and identical wearing capabilities, and are identically suited to the installation, completely describe the relative costs and capabilities of each.

7. AN EQUAL AND SUBTITUTIONS

A. AN EQUAL AND SUBSTITUTIONS will be considered by the Architect. Each such request shall include a comparative table showing the characteristics of the specified material and the proposed SUBSTITUTE or AN EQUAL. The Architect’s decision will be final.

B. SIXTY CALENDAR DAYS after the Contractor is given the "Notice to Proceed," he shall submit materials he proposed to use for the project for approval by the Architect. No AN EQUAL OR SUBSTITUTION will be considered unless submitted within the forty five working days after "Notice to Proceed".

C. AN EQUAL is a material, article or equipment of other

manufacturers and vendors which have similar physical and mechanical characteristics and will perform equally the duties imposed by the general design as the one specified. A SUBSTITUTION is a material, article or equipment of other manufacturers and vendors which will not have the same physical and mechanical characteristic as the one specified. For a material to be considered AN EQUAL Contractor will submit a comparative table showing the characteristics of specified material and the proposed AN EQUAL. Also the submittal must include full and complete technical data, catalog cuts, performance and test data of the specified material and the AN EQUAL.

D. Architect will inform the Contractor in written within the next 20 working days if material submitted is considered AN EQUAL or an SUBSTITUTE, and if found acceptable. If no written communication is received within the 20 working days, Contractor will interpret the AN EQUAL or SUBSTITUTE is not approved and another can be submitted. No SUBSTITUTE or AN EQUAL will be considered if not submitted within forty five working days after "Notice to Proceed". Construction Contract Time will not be increased to account for delays in not accepting a SUBSTITUTE or AN EQUAL.

E. Once Contractor is informed material is considered a SUBSTITUTE and not AN EQUAL, Contractor shall inform the Architect if a complete evaluation of the material will be performed. If this is the case the Architect will be reimbursed its costs. The Architect decision will be final.

F. The Architect will consider proposals for substitution of materials, equipment, and methods only when such proposals are accompanied by full and complete technical data and all other information required by the Architect to evaluate the proposed substitution.

G. Where the phrase "or equal" or "or equal as approved by the Architect" occurs in the Contract Documents, do no assume that material, equipment or methods will be approved for this Work by the Architect.

H. The decisions of the Architects shall be final.

I. Verify prior to bidding that all specified items will be available in time for installation during orderly and timely progress of the Work. In the event specified item or items will not be so available, so notify the Architect prior to receipt of bids. Costs of delays because of non-availability of specified items, when such delays could have been avoided by the Contractor, will be back-charged as necessary and shall not be borne by the Owner.

J. Reimbursement of Architect's costs

1. In the event substitutions are proposed to the Architect after the Contract has been awarded, the Architect will record all time used by him and his consultants in evaluation of each such proposed substitution.
2. Whether or not the Architect approves a proposed substitution the Contractor shall promptly upon receipt of the Architect's billing reimburse the Architect at the rate of two and one-half times the direct cost to the Architect and his consultants for all time spent by them in the evaluation of the proposed substitution.

8. MANUALS

A. General
1. Where Manuals are required to be submitted covering items included in this Work, prepare all such Manuals in durable plastic binders approximately 8 1/2 by 11 inches in size.

B. Extraneous data
1. Where contents of Manuals includes manufacturers' catalog pages, clearly indicate the precise items included in this installation and delete or otherwise clearly indicated all manufacturers' data with this installation is not concerned.

C. Number of copies required
1. Unless otherwise specifically directed by the Architect or stipulated in the pertinent Section of these Specifications, deliver three (3) copies of the Manuals to the Owner.

9. IDENTIFICATION OF SUBMITTALS

A. General
1. Consecutively number all submittals
2. Accompany each submittal with a letter of transmittal showing the transmittal number, date of transmittal, Specifications Section or Drawing number to which the submittal pertains, brief description of the material submitted, and the company name of the originator of the submittal.

B. Internal identification
1. On at least the first page of each copy of each submittal, indicate the transmittal number corresponding to the letter of transmittal by which the submittal was accompanied.

C. Resubmittals
1. When material is resubmitted for any reason, transmit

under a new letter of transmittal with a new number; indicate by reference to previous submittal that this is a resubmittal.

D. Submittal log
   1. Maintain an accurate submittal log for the duration of the construction period, showing status of all submittals of all types.
   2. Make the log available to the Architect for review upon request.

10. COORDINATION OF SUBMITTALS

A. General
   1. Prior to submittal for Architect's review, use all means necessary to fully coordinate all material, including the following procedures:
      a) Determine and verify all field dimensions and conditions, catalog numbers, and similar data.
      b) Coordinate as required with all trades and with all public agencies involved.
      c) Secure all necessary approvals from public agencies and other; signify by stamp or other means that all required approvals have been obtained.
      d) Clearly indicate all deviations from the Contract Documents.

B. Grouping of submittals
   1. Unless otherwise specifically permitted by the Architect, make all submittals in groups containing all associated items.
   2. The Architect may reject partial submittals as not complying with the provisions of the Contract Documents.

11. TIMING OF SUBMITTALS

A. General
   1. Make all submittals far enough in advance of scheduled dates for installation to provide all required time for reviews, for securing necessary approvals, for possible revision and resubmittals, and for placing orders and securing delivery.
   2. In scheduling, allow at least twenty full working days for the Architect's review following his receipt of the submittal.
   3. Prepare a list of all materials and equipment for which approval of shop drawings is required. This list shall be submitted to the Architect not later than 15 working days after the order to proceed with the construction has been granted.
   4. The Contractor shall submit evidence not later than 20 working days after the order to proceed of construction

has been granted, of having contracted the work of all subcontractors and evidence of having placed orders of purchase for all other materials of work which are not being subcontracted.

5. Contractor shall submit all shop drawings for the Architect's approval not later than 45 working days after the order to proceed of the Construction has been granted.

12. ARCHITECT'S REVIEW

A. Review by the Architect does not relieve the Contractor from responsibility for errors which may exist in the submitted data.

B. Revisions

1. Make revisions required by the Architect.
2. If the Contractor considers any required revision to be a change, he shall so notify the Architect.
3. Make only those revisions directed or approved by the Architect.

(A:01-340)

SECTION 01380: CONSTRUCTION PHOTOGRAPHS

1. DESCRIPTION

   A. Work included: Provide photographs taken at the specified stages during construction.

2. QUALITY ASSURANCE

   A. Secure the services of a professional photographer who is skilled and experienced in construction photography and whose work samples are acceptable to the Architect.

   B. Do not replace the photographer without the Architect's written approval.

3. SUBMITTALS

   A. Except as otherwise directed and paid for, submit three prints of each photograph.

4. CONSTRUCTION PHOTOGRAPHS

   A. Provide black and white prints:
      1. Size: 8" x 10"
      2. Type: Smooth surface, glossy print, single weight paper with white base.

   B. On the back of each print, in a manner not damaging to the print, show:
      1. Job name;
      2. Location from which photographed;
      3. Date of photograph;
      4. Photographer's name, address, and photograph number.

   C. Require the photographer to retain the negatives for at least one year following Date of Substantial Completion and to provide additional prints to the Owner during that period at the prevailing commercial rates for such prints.

   D. Do not permit prints to be issued for any other purpose without specific written approval from the Architect.

5. CONSTRUCTION PHOTOGRAPHY

   A. Except as otherwise specifically approved by the Architect, make the photographs within three calendar days of the date of the Contractor's application for progress payment.
      1. To the maximum extent practicable, make photographs at approximately the same time of day
      2. When inclement weather is anticipated, consult

with the Architect and determine acceptable alternative arrangements.

B. Except as otherwise specifically approved by the Architect, make the photographs from eight separate locations around the Work.

1. Select the locations to provide diversified overall views of the Work, from positions which are expected to remain accessible throughout progress of the Work.
2. Identify each location by word description, by marked drawing, or by such other means as acceptable to the Architect, to enable future photographs to be taken from the same position.
3. When so directed by the Architect because of the stage of construction, change one or more of the locations to new locations inside or outside the buildings the Architect directs.

C. Make each photograph clear, in focus, with high resolution and sharpness, and with minimum distortion.

(A:01-380)

SECTION 01410: TESTING LABORATORIES

1. DESCRIPTION

A) Work included:
1. Any material and/or equipment shall be subject to test to determine that materials provided for the Work meet the specified requirements.
2. Where no testing requirements are described in various Sections of these Specifications, nevertheless the Owner may require testing to be performed under current pertinent standards for testing.

B) Laboratory:
1. The Owner will select pre-qualified testing laboratory or laboratories as deemed necessary.
2. Normal and regular tests to verify the quality of materials and to determine if they meet the specified requirements shall be paid by the Contractor.
3. Additional tests exceeding normal and regular shall be paid as determined by the results of such tests.
   a. Additional tests requested by Owner and if results are not according to requirements, shall be paid by the Contractor.
   b. Additional tests requested by Owner and if results are according to requirements, shall be paid by Owner.

2. QUALITY ASSURANCE

A) Qualifications of testing laboratory:
1. The testing laboratory will be qualified to the Owner's approval in accordance with ASTM E-329-70 "Recommended Practice for Inspection and Testing Agencies for Concrete and Steel Used in Construction".

B) Codes and standards:
1. Testing, when required, will be in accordance with all pertinent codes and regulations and with selected standards of the American Society for Testing and Materials.

3. PRODUCT HANDLING

A) Promptly process and distribute all required copies of test report and related instructions to ensure all necessary retesting and/or replacement of materials with the least possible delay in progress of the Work.

B) The Contractor shall provide those materials necessary

to facilitate the taking of samples for testing.

4. COOPERATION WITH TESTING LABORATORY

A) Representatives of the testing laboratory shall have access to the Work at all times. Provide facilitates for such access in order that the laboratory may properly perform its functions.

5. SCHEDULES FOR TESTING

A) Establishing schedule
   1. By advance discussion with the testing laboratory approved by the Owner, determine the time required for the laboratory to perform its tests and to issue of its findings.
   2. Provide all required time within the construction schedule.

B) Revising schedule
   1. When changes of construction schedule are necessary during construction, coordinate all such changes of schedule with the testing laboratory as required.

C) Adherence to schedule
   1. When the testing laboratory is ready to test according to the determined schedule but is prevented from testing or taking specimens due to incompleteness of the Work, all extra costs for testing attributable the delay may be back charged to the Contractor.

6. TAKING SPECIMENS

A) All specimens and samples for testing, unless otherwise provided in these Contract Documents, will be taken by the testing laboratory; all sampling equipment and personnel will be provided by the testing laboratory; and all deliveries of specimens and samples to the testing laboratory will be performed by the testing laboratory.

(A:01-410)

SECTION 01500: TEMPORARY CONSTRUCTION AND FACILITIES

1. DESCRIPTION

A) Scope - The work required under this section consists of providing all temporary construction and facilities necessary to complete the work as indicated on drawings and described in specifications.

B) Contractor - Except where designated otherwise, the term "Contractor", as employed herein, refers to the General Contractor.

2. TEMPORARY FIELD OFFICE AND SHEDS

A) Office - Contractor shall provide and maintain a suitable temporary field office at the project site for his own use and the use of representatives of the Owner or Architect. The office shall contain a minimum of 350 square feet of floor space to be used by representatives of the Architect or Owner; it shall be provided with adequate electric lighting, toilet and lavatory, telephone, file racks for storage of drawings, counter top for drawing references, storage shelves, a desk, a table 4'-0"- 8'-0" and a minimum of 10 chairs, in addition to furnishings required by the Contractor for his own use. Locate office where indicated or directed and remove when work is completed. Provide air conditioning to the 350 square feet.

B) Sheds - Contractor shall provide and maintain such additional offices, storage sheds and other temporary buildings or trailers on the project site as required for his own use. (Sub-Contractors shall provide their own temporary sheds or trailers). Location of sheds and trailers shall be approved by Architect and the Owner; remove sheds when work is completed, or as directed.

3. TEMPORARY FENCE

A) Scope - Prior to any excavation work, the Contractor shall erect a temporary fence along the contract limits as indicated in the drawings.

B) Construction - Fence framing shall be six feet high, using 4 by 4 inch posts spaced approximately eight feet apart and with 2 by 4 inch top, bottom and intermediate horizontal rails. Cover framing with galvanized corrugated steel sheets. Provide gate with opening and at locations as required. Paint fence with 2 coats of exterior paint. Color to be selected by the Architect. Remove at termination of the Project.

4. TEMPORARY SCAFFOLDS, STAGING, AND SAFETY DEVIES

A) Provide, erect, maintain and remove when directed, all scaffolding, guards, railings, stairs, etc., as required by local codes or laws, for the protection of workmen and the public. The construction, inspection, and maintenance of the above items shall comply with all safety codes and regulations as applicable to the project.

5. PROJECT SIGNS

A) Provide two project signs located on site where indicated or directed. Sign shall meet the requirements of Specification 01510.

6. TEMPORARY WATER DURING CONSTRUCTION

A) The CONTRACTOR shall make the necessary arrangements and provide all water required during the entire construction period. Install meter of size to accommodate requirements. The metered cost for temporary water shall be borne by the CONTRACTOR.

B) Where the water system at the project does not have sufficient pressure to provide water, the CONTRACTOR shall provide temporary pumps, tanks and compressors as necessary to produce the required pressures.

7. TEMPORARY TOILET FACILITIES

A) CONTRACTOR shall provide and maintain an adequate number of temporary toilets with proper enclosures as necessary for use of workmen during construction. Locate toilets where directed; connect to water and sewer as soon as work will allow. Keep toilets clean and comply with all local and state health requirements and sanitary regulations. Until water and sewer connections are available, toilet facilities shall consist of the prefabricated chemical type. Remove temporary toilets when directed. The permanent plumbing fixtures shall not be used during construction.

8. TEMPORARY ELECTRICITY DURING CONSTRUCTION

A) General Requirements - The CONTRACTOR shall make the necessary arrangements and provide all temporary electric service and lighting required during the entire construction period. The metered cost of electricity used shall be borne by the CONTRACTOR.

B) Capacity and Type - The electric service shall be of sufficient capacity and characteristics to supply the proper current for the various types of construction tools, motors,

welding machines, lights, air conditioning, pumps, and other work required. All necessary temporary wiring, panelboards, outlets, switches, lamps, fuses, controls, and accessories (except extension cords) shall be provided. A sufficient number of electric outlets shall be provided; locate outlets so that 50 ft. long extension cords reach all work requiring light or power.

9. LIFTING DEVICES AND HOISTING FACILITIES

A) CONTRACTOR shall provide cranes, hoists, towers, and other lifting devices necessary for the proper and efficient movement of materials; provide operating personnel for equipment as required. Equipment shall be provided with proper guys, bracing and other safety devices as required by local codes. Remove towers and hoisting equipment when they are no longer needed, or as directed by the Architect.

10. WATCHMAN

A) CONTRACTOR shall employ watchmen to guide the site and premises of the project at all times, except during regular working hours. The watchmen service shall be continuous from beginning of work until substantial completion. Provide watchmen's clock and station located as directed to insure complete coverage by watchmen. CONTRACTOR shall be fully responsible for replacement of stolen materials delivered to the site at his own cost. Stolen materials shall not be certified for payment. Stolen material already certified shall be replaced by the CONTRACTOR.

(A:01-500)

SECTION 01510: PROJECT SIGN

1. SCOPE

The Contractor shall furnish and erect two signs at the project site identifying the project as specified and as shown in the detail herewith attached at the location designated by the Architect.

2. WORK TO BE DONE

The project sign shall be 8ft. x 6ft. with clear and well visible letters, placed in prominent locations selected by the Architect and maintained in good conditions until completion of the project.

The sign shall be as follows:

Supports	Structural lumber, pressure treated.
Face	0.032 Aluminum Sheet, mounted on an exterior plywood.
Bolts and Nuts	ASTM A307, galvanized ASTM A153, cadmium plated ASTM A165, Type NS, or zinc plated ASTM A164 Type GS.
Wood Screws	18-8 Stainless steel or brass.
Nails	Galvanized or aluminum coated.
Rough Hardware	Galvanized steel, 18-8 stainless steel, brass, or aluminum.

All surfaces of the project sign and supports shall be given three coats of a suitable wood-protective paint. The Contractor hereunder shall provide the services of a sign painter to letter the sign. At completion of the work under this contract the sign shall remain the property of the Architect. Project sign will not be erected on public highway rights-of-way. Location and height of sign will be coordinated with the agency responsible for highway or street safety in the area, if any possibility exist for obstruction to traffic line of sight.

The name of the project and the additional information to be painted will be informed to the Contractor, by the Architect, as soon as the contract is awarded to him. The project sign shall be installed at the commencement of the project.

(A:01-510)

SECTION 01614: PRODUCT HANDLING

1. SCOPE

A) Work included: Protect products scheduled for use in the Work by means including, but not necessarily limited to, those described in this Section.

2. QUALITY ASSURANCE

A) Include within the Contractor's quality assurance program such procedures as are required to assure full protection of work and materials.

3. MANUFACTURERS' RECOMMENDATIONS

A) Except as otherwise approved by the Architect, determine and comply with manufacturers' recommendations on product handling, storage, and protection.

4. PACKAGING

A) Deliver products to the job site in their manufacturer's original container, with labels intact and legible.
   1. Maintain packaged materials with seals unbroken and labels intact until time of use.
   2. Promptly remove damaged material and unsuitable items from the job site, and promptly replace with material meeting the specified requirements, at no additional cost to the Owner.

B) The Architect may reject as non-complying such material land products that do not bear identification satisfactory to the Architect as to manufacturer, grade, quality, and other pertinent information.

6. PROTECTION

A) Protect finished surfaces, including jambs and soffits of openings used as passageways, through which equipment and materials are handled.

B) Provide protection for finished floor surfaces in traffic areas prior to allowing equipment or materials to be moved over such surfaces.

C) Maintain finished surfaces clean, unmarred, and suitably protected until accepted by the Owner.

7. REPAIRS AND REPLACEMENTS

A) In event of damage, promptly make replacements and repairs to the approval of the Architect and at no additional cost to the Owner.

B) Additional time required to secure replacements and to make repairs will not be considered by the Architect to justify an extension in the Contract Time of Completion.

(A:01-614)

SECTION 01710: CLEANING

1. SCOPE

   A) Throughout the construction period, maintain the buildings and site in a standard of cleanliness as described in this Section.

2. QUALITY ASSURANCE

   A) Conduct daily inspection, and more often if necessary, to verify that requirements for cleanliness are being met.

3. CLEANING MATERIALS AND EQUIPMENT

   A) Provide required personnel, equipment, and materials needed to maintain the specified standard of cleanliness.

4. COMPATIBILITY

   A) Use only the cleaning materials and equipment which are compatible with the surface being cleaned, as recommended by the manufacturer of the material.

5. PROGRESS CLEANING

   A) General:
      1. Retain stored items in an orderly arrangement allowing maximum access, not impeding traffic or drainage, and providing required protection of materials.
      2. Do not allow accumulation of scrap, debris, and waste material, and other items not required for construction of this work.
      3. At least once a week, and more often if necessary completely remove all scrap, debris, and waste material from the job site.
      4. Provide adequate storage for all items awaiting removal from the job site, observing requirements for fire protection and protection of the ecology.

   B) Site:
      1. Daily, and more often if necessary, inspect the site and pick up all scrap, debris, and waste material. Remove such items to the place designated for their storage.
      2. Weekly, and more often if necessary, inspect all arrangements of materials stored on the site. Restack, tidy, or otherwise service arrangements to meet the requirements of these specifications.
      3. Maintain the site in a neat and orderly condition at all items.

C) Structures

1. Weekly, and more often if necessary, inspect the structures and pick up all scrap, debris, and waste material. Remove such items to the place designated for their storage.
2. Weekly, and more often if necessary, sweep interior spaces clean.
   a. "Clean," for the purposed of this subparagraph, shall be interpreted as meaning free from dust and other material capable of being removed by use of reasonable effort and hand-held broom.
3. As required preparatory to installation of succeeding materials, clean the structures or pertinent portions thereof to the degree of cleanliness recommended by the manufacturer of the succeeding material, using equipment and materials required to achieve the necessary cleanliness.
4. Following the installation of finish floor materials, clean the finish floor daily (and more often if necessary) at all times while work is being performed in the space in which finish materials are installed.
   a. "Clean," for the purpose of this subparagraph, shall be interpreted as meaning free from foreign material which, in the opinion of the Architect, may be injurious to the finish floor material.

6. FINAL CLEANING

A) "Clean," for the purpose of this Article, and except as may be specifically provided otherwise, shall be interpreted as meaning the level of cleanliness generally provided by skilled cleaners using commercial quality building maintenance equipment and materials.

B) Prior to completion of the work, remove from the job site all tools, surplus materials, equipment, scrap, debris, and waste. Conduct final progress cleaning as described.

C) Site:

1. Unless otherwise specifically directed by the Architect, broom clean paved areas on the site and public paved areas adjacent to the site.
2. Completely remove resultant debris.

D) Structures

1. Exterior:
   a. Visually inspect exterior surfaces and remove all traces of soil, waste materials, smudges,

and other foreign matter.

b. Remove all traces of splashed materials from adjacent surfaces.

c. If necessary to achieve a uniform degree of cleanliness, hose down the exterior of the structure.

d. In the event of stubborn stains not removable with water, the Architect may require light sandblasting or other cleaning at no additional cost to the owner.

2. Interior:

a. Visually inspect interior surfaces and remove all traces of soil, waste materials, smudges, and other foreign matter.

b. Remove paint droppings, spots, stains, and dirt from finished surfaces.

3. Glass: Clean inside and outside.

4. Polished surfaces: To surfaces requiring routine application of buffed polish, apply the polish recommended by the manufacturer of the material being polished.

E) Schedule final cleaning as approved by the Architect to enable the owner to accept a completely clean work.

7. CLEANING DURING OWNER'S OCCUPANCY

A) Should the owner occupy the work or any portion thereof prior to its completion by the Contractor and acceptance by the owner, responsibilities for interim and final cleaning shall be as determined by the Architect in accordance with the General Conditions of the Contract.

(A:01-710)

SECTION 01730: OPERATION AND MAINTENANCE DATA

1. SCOPE

   A) Work included: To aid the continued instruction of operating and maintenance personnel, and to provide a positive source of information regarding the products incorporated into the Work, furnish and deliver the data described in this Section and in pertinent other Sections of these Specifications.

2. QUALITY ASSURANCE

   A) In preparing data required by this Section, use only personnel who are thoroughly trained and experienced in operation and maintenance of the described items, completely familiar with the requirements of this Section, and skilled in technical writing to the extent needed for communicating the essential data.

3. SUBMITTALS

   A) Submit two copies of a preliminary draft of the proposed Manual or Manuals to the Architect for review and comments.

   B) Unless otherwise directed in other Sections, or in writing by the Architect, submit three copies of the final Manual to the Architect prior to indoctrination of operation and maintenance personnel.

4. INSTRUCTION MANUALS

   A) Where instruction Manuals are required to be submitted under other Sections of these Specifications, prepare in accordance with the provisions of this Section.

   B) Format:
      1. Size: 8-1/2" X 11"
      2. Paper: White bond, at least 20 lb. weight
      3. Text: Neatly written or printed
      4. Drawings: 11" in height preferable; bind in with text; foldout acceptable; larger drawings acceptable but fold to fit within the Manual and provide a drawing pocket.

5. Flysheets: Separate each portion of the Manual with neatly prepared flysheets briefly describing contents of the ensuing portion; flysheets may be in color.
6. Binding: Use heavy-duty plastic or fiberboard covers with binding mechanism concealed inside the Manual; 3-ring binders will be acceptable; all binding is subject to the Architect's approval.
7. Measurements: Provide all measurements in U.S. standard units such as feet-and-inches, lbs., and cfm.; where items may be expected to be measured within ten years in accordance with metric formulate, provide additional measurements in the "International System of Units" (SI).

C) Provide front and back covers for each Manual, using durable material approved by the Architect, and clearly identified on or through the cover with at least the following information:

(OPERATING AND MAINTENANCE INSTRUCTIONS)
(name and address of Work)
(name of Contractor)
(general subject of this Manual)
(space for approval signature of the Architect and approval date)

D) Contents: Include at least the following:
1. Neatly typewritten index near the front of the Manual, giving immediate information as to location within the Manual of all emergency information regarding the installation.
2. Complete instructions regarding operation and maintenance of all equipment involved including lubrication, disassembly and reassembly.
3. Complete nomenclature of all parts of all equipment.

4. Complete nomenclature and part number of all replaceable parts, name and address of nearest vendor, and all other data pertinent to procurement procedures.
5. Copy of all guarantees and warranties issued.
6. Manufacturers' bulletins, cuts, and descriptive data, where pertinent, clearly indicating the precise items included in this installation and deleting, or otherwise clearly indicating, all manufacturers' data with which this installation is not concerned.
7. Such other data as required in pertinent Sections of these Specifications.

5. INSTRUCTION MANUALS

A) Preliminary:
1. Prepare a preliminary draft of each proposed Manual.
2. Show general arrangement, nature of contents in each portion, probable number of drawings and their size, and proposed method of binding and covering.
3. Secure the Architect's approval prior to proceeding.

B) Final: Complete the Manuals in strict accordance with the approved preliminary drafts and the Architect's review comments.

(A:01-730)

SECTION 01800: PROJECT MANAGER & COORDINATION

1. RELATED DOCUMENTS

A) Drawings and general provisions of the Contract, including the General Conditions, the Supplementary Special Conditions and all division – 1 Specifications section, apply to the Work of this Section.

2. SUMMARY

A) This Section includes administrative provisions for coordinating construction operations of Project including, but not limited to, following:

1. General project coordination procedures.
2. Coordination Drawings.
3. Project meeting.

3. COORDINATION

A) Coordination: Coordinate construction operation included in various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, Connection, and Operation:

1. Schedule construction operations in sequence required to obtain the best result when installing of one part of the Work depends on installation of other components, before of after its own installation.
2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.
4. If necessary, prepare memoranda for distribution to each party involved,

outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

5. Prepare similar memoranda for Owner and separate Contractors if coordination of their Work is required.
6. Administrative procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

    1. Preparation of Contractor’s Schedule.
    2. Preparation of the Schedule of Valves.
    3. Installation and removal of temporary facilities and controls.
    4. Delivery and processing of submittals.
    5. Progress conferences.
    6. Project Closeout activities.

4. SUBMITTALS

A) Coordination Drawings: Prepare coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components of coordination is required for installation of precuts and materials fabricated by separate entities.

1. Indicate relationship of components shown on separate Shop Drawings.
2. Indicate required installation sequences.
3. Refer to Division 15 Section “Basic Mechanical Materials and Methods” for specific Coordination Drawing requirements for mechanical installations.
4. Refer to Division 16 Section “Basic Electrical Materials and Methods” for

specific Coordination Drawing requirements for electrical installation.

5. PROJECT MEETINGS

A) The Owner shall schedule and conduct meetings and conferences at Project site, unless otherwise indicated and shall assume the following responsibilities for such meetings:

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of the date and time of each meeting. Notify Architect/Engineer of schedule meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Architect/Engineer, within (3) three days of the meeting.

B) Preconstruction conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Architect/Engineer, but no later than (15) fifteen days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Owner, Architect/Engineer, and their consultant: contractor and its superintendent, major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

c) Agenda: Discuss items of significance that could affect progress, including the following:

1. Tentative construction schedule.
2. Phasing.
3. Critical work sequencing.
4. Designation of responsible personnel.
5. Procedures for processing field decisions and Change Orders.
6. Procedures for processing Application for payment.
7. Distribution of the Contract Documents.
8. Submittal procedures.
9. Preparation of Record Documents.
10. Use of the premises.
11. Responsibility for temporary facilities and controls.
12. Parking availability for temporary facilities and controls.
13. Office, work, and storage areas.
14. Equipment deliveries and priorities.
15. First Aid.
16. Security.
17. Progress cleaning.
18. Working hours.

D) Pre-installation conferences: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination of integration with other materials and installations that have proceeded of will follow, shall attend the meeting. Advise Architect/Engineer of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

1) Contract Documents.
2) Options.
3) Related Change Orders.
4) Purchases.
5) Deliveries.
6) Submittals.
7) Review of mockups.
8) Possible conflicts.
9) Compatibility problems.
10) Time schedules.
11) Weather limitations.
12) Manufacture’s written recommendations.
13) Warranty requirements.
14) Compatibility of materials.
15) Acceptability of substrates.
16) Temporary facilities and controls.
17) Space and access limitations.
18) Regulations of authorities having jurisdiction.
19) Testing and inspecting requirements.
20) Required performance results.
21) Protection of construction and personnel.

E) Record significant conference discussions, agreements and disagreements.

A) Do not proceed with installation if the conference cannot be successfully concluded. Initiative whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest easible date.

B) Progress Meetings: Conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation payment requests.

1. Attendees: In addition to representatives of Owner and Architect/Engineer, each contractor, subcontractor, supplier and other entity concerned with current progress of involved in planning, coordination, or performance of future activities shall be

represented at these meeting. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Review and correct of approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of project.
3. Contractor’s Construction Schedule Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor’s construction schedule. Determine how construction behind schedule will be expedites; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
4. Review present and future needs of each entity present, including the following:

    1) Interface requirements.
    2) Sequence of operations.
    3) Status of submittals.
    4) Deliveries.
    5) Off-site fabrication.
    6) Access.
    7) Site utilization.
    8) Temporary facilities and controls.
    9) Work hours.
    10) Hazards and risks.
    11) Progress cleaning.
    12) Quality and work standards.
    13) Change Orders.
    14) Documentation of information for payment requests.

A) Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in

narrative form, of progress since the previous meeting and report.

B) Schedule Updating: Revise contractor’s Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

END OF SECTION

SECTION 01810: CONSTRUCTION PROGRESS DOCUMENTATION

1. RELATED DOCUMENTS

A) Drawings and general provisions of the Contract, including the General Conditions, the Supplementary General Conditions, the Special Conditions, the Supplementary Special Conditions and all Division – 1 Specifications sections, apply to the Work of this Section.

2. SUMMARY

A) This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Contractor’s Construction Schedule.
2. Submittals Schedule.
3. Daily construction report.
4. Field condition reports.
5. Special reports.

B) Related Sections include the following:

1. Division 1 Section “Payment Procedures” for submitting the Schedule of Values.
2. Division 1 Section “Project Management and Coordination” for submitting and distributing meeting and conference minutes.
3. Division 1 Section “Submittals” for submitting schedules and reports.
4. Division 1 Section “Quality Control Services” for submitting a schedule of tests and inspections.
5. Division 1 Section “Closeout Procedures” for submitting photographic negatives as Project Record Documents at Project closeout.

3. DEFINITIONS

A) Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction

project. Activities included in a construction schedule consume time and resources.

1. Critical activities are activities on the critical path. They must start and finish on the planned early star and finish times.
2. Predecessor activity is an activity that must be completed before a given activity can be started.

C) CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

D) Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall Project duration and contains no float.

E) Event: The starting or ending point of an activity.

F) Float: The measure of leeway in starting and completing an activity:

1. Float time is not for the exclusive use or benefit of either Owner of Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones an Contract completion date.
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.
3. Total float is the measure of leeway in stating of completing an activity without adversely affecting the planned Project completion date.

G) Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

H) Major Area: A story of construction, a separate building, or a similar significant construction element.

H) Milestone: A key or critical point in time for reference or measurement.

I) Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

4. SUBMITTALS

A) Qualification Data: For firms and persons specified in “Quality Assurance” Article and in-house scheduling personnel to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

B) Submittals Schedule: Submit (7) seven copies of schedule. Arrange the following information in a tabular format:

1. Scheduled date form first submittal.
2. Specification Section number and title.
3. Submittal category(action or informational).
4. Name of subcontractor.
5. Description of the Work covered.
6. Scheduled date for Architect’s and Resident Inspector’s final release or approval.

C) Preliminary Network Diagram: Submit (7) seven printed copies; one a single sheet of reproducible media, and one a print; large enough to shown entire network for entire construction period.

D) Contractor’s Construction Schedule: Submit (7) seven printed copies of initial schedule, one a reproducible print and one a blue or black-line print, large enough to show entire schedule for entire construction period.

1. Submit and electronic copy of schedule, using software indicated, on compact disc or on 3-1/2 inch (89 – mm) diskettes, formatted to bold 1.44 MB of data, and labeled to comply with requirements for submittals. Include type of schedule (Initial of Updated) and date on label.

E) CPM Reports: Concurrent with CPM schedule, submit (7) seven printed copies of each of the following computer generated reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early star date, early finish date, late star date, late finish date, and total float.

1. Activity Report: List of all activities sorted by activity number and then early starts date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early star date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor’s total earnings from the Notice to Proceed until most recent Application for Payment.

F) Daily Construction Reports: Submit (2) two copies at weekly intervals.

G) Field Condition Reports: Submit (2) two copies at time of discovery of differing conditions.

H) Special Reports: Submit (2) two copies at time of unusual event.

5. QUALITY ASSURANCE

A) Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting. Qualifications shall be evaluated by

the PBA who will make a final determination as to the acceptability of proposed consultant.

B) Year 2000 (Y2K) Compliance: Computer software for scheduling shall be capable of accurately processing, sequencing, calculating, transmitting, and receiving date data from, into, and between all dates before, through, and after January 1, 2000, including leap-year calculations.

C) Pre-scheduling Conference: Conduct conference at Project site to comply with requirements in Division 1 Section “Project Management and Coordination”. Review methods and procedures related to the Preliminary Construction Schedule and Contractor’s Construction Schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including phasing, work stages, area separations, interim milestones and partial Owner occupancy.
4. Review delivery dates for Owner-furnished products.
5. Review time required for review of submittals and re-submittals.
6. Review requirements for tests and inspections by independent testing and inspection agencies.
7. Review time required for completion and startup procedures.
8. Review and finalize list of construction activities to be included in schedule.
9. Review submittal requirements and procedures.
10. Review procedures for updating schedule.

6. COORDINATION

A) Coordinate preparation and processing of schedules and reports with performance of

construction activities and with scheduling and reporting of separate contractors.

B) Coordinate Contractor’s Construction Schedule with the Schedule of values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work parties involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

7. PRODUCTS

A) SUBMITTALS SCHEDULE

1. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required arranged in chronological order by dates required by construction schedule. Include time required for review, re-submittal, ordering, manufacturing, fabrication, and delivery when establishing dates.

a. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Value, and Contractor’s Construction Schedule.
b. Final Submittal: Submit concurrently with the first complete submittal of Contractor’s Construction Schedule.

B) CONTRACTOR’S CONSTRUCTION SCHEDULE, GENERAL

1. Procedures: Comply with procedures contained in AGC’s “Construction Planning & Scheduling”.
2. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Final Completion:

a. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

3. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
   a. Activity Duration: Define activities so no activity is longer than (20) twenty days, unless specifically allowed by Architect.

4. Procurement Activities; Include procurement process activities for long lead items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
5. Submittal Review Time: Include review and re-submittal times indicated in Division 1 Section “Submittal Procedures” in schedule. Coordinate submittal review times in Contractor’s Construction Schedule with Submittals Schedule.
6. Startup and Testing Time: Include not less than (10) ten days for startup and testing.
7. Submittal Completion: Indicate completion in Advance of date established for Substantial Completion, and allow time for Architect’s and Resident Inspector’s administrative procedures necessary for certification of Substantial Completion.

C) CONSTRAINTS: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.

2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
3. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicate in Division 1 Section “Summary” Delivery dates indicated stipulate the earliest possible delivery date.
4. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 1 Section “Summary”. Delivery dates indicated stipulated the earliest possible delivery date.
5. Work Restrictions: Show the effect of the following items on the schedule:

    a. Coordination with existing construction.
    b. Limitation of continued occupancies.
    c. Uninterruptible services.
    d. Partial occupancy before Substantial Completion.
    e. Use of premises restrictions.
    f. Provisions for future construction.
    g. Seasonal variations.
    h. Environmental control.

6. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

    a. Subcontract awards.
    b. Submittals.
    c. Purchases.
    d. Mockups.
    e. Fabrication.
    f. Sample testing.
    g. Deliveries.
    h. Installation.
    i. Tests and inspections.
    j. Adjusting.
    k. Curing.

l. Startup and placement into final use and operation.

7. Area Separations: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:

   a. Structural completion.
   b. Permanent space enclosure.
   c. Completion of mechanical installation.
   d. Completion of electrical installation.
   e. Substantial Completion.

8. Milestones: Include milestone indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
9. Cost Correlation: At the head of schedule, provide a cost correlation line, indication planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.

   a. Refer to Division 1 Section “Payment Procedures” for cost reporting and payment procedures.
   b. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragments to demonstrate the effect of the proposed change on the overall project schedule.
   c. Computer Software: Prepare schedules using a program that has been developed specifically to manage construction schedules.
   d. Primavera Sure Trak Version 3.0 for Windows 65/98/NT operating systems.

e. Contractor shall purchase the above referenced software, the cost of which shall be included as part of the Contract. The software shall be licensed to the PBA. Contractor may, at his own expense, purchase additional licenses for his internal use.

8. CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

A) Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's Construction Schedule within (30) thirty days of date established for the Notice to Proceed. Base schedule on the Preliminary Construction schedule and whatever updating and feedback was received since the star of Project.

B) Preparation: Indicate each significant construction activity separately. Identify first workday of each with a continuous vertical line.

1. For Construction activities that require 3 months or longer to complete, indicate an estimated completion percentage in (10) ten percent increments within time bar.

9. CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A) General: Prepare network diagrams using AON (activity-on-node) format.

B) Preliminary Network Diagram: Submit diagram within (14) fourteen days of date established for the Notice to Proceed. Outline significant construction activities for the first (60) sixty days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C) CPM Schedule: Prepare Contractor's Construction Schedule using a CPM network analysis diagram.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted

for use no later than (30) thirty days after date established for the Notice to Proceed.

2. Conduct educational workshops to train and inform key Project personnel, including subcontractor's personnel, in proper methods of providing data and using CPM schedule information.
3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
4. Use "One workday" as the unit of time.

9. CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)(CONT.)

D) CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:

    a. Preparation and processing of submittals.
    b. Purchase of materials.
    c. Delivery.
    d. Fabrication.
    e. Installation.

2. Processing: Process data to produce output data or a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
3. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

a. Sub networks on separate sheets are permissible for activities clearly of the critical path.

4. Initial Issue of Schedule: Prepare initial network diagram form a list of straight “carly start-total float” sort. Identify critical activities. Prepare tabulated reports showing the following:

   a. Contractor or subcontractor and the Work or activity.
   b. Description of activity.
   c. Principal events of activity.
   d. Immediate preceding and succeeding activities.
   e. Early and late start dates.
   f. Early and late finish dates.
   g. Activity duration in workdays.
   h. Total float or slack time.
   i. Average size of workforce.
   j. Dollar value of activity (coordinated with the Schedule of Values).

5. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

   a. Identification of activities that have changed.
   b. Changes in early and late start dates.
   c. Changes in early and late finish dates.
   d. Changes in activity durations in workdays.
   e. Changes in the critical path.
   f. Changes in total float of slack time.
   g. Changes in the Contract Time.

6. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.

   a. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.

b. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
c. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
d. Prepare list for case of comparison with payment requests; coordinate timing with progress meetings:

1. In both value summary lists, tabulate “actual percent complete” and cumulative value completed” with total at bottom.
2. Submit value summary printouts one week before each regularly schedule progress meeting.

10. REPORTS

A) Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. Approximate count of personnel at project site.
3. High and low temperatures and general weather conditions.
4. Accidents.
5. Meetings and significant decisions.
6. Unusual events (refer to special reports).
7. Stoppages, delays, shortages, and losses.
8. Meter readings and similar recordings.
9. Orders and requests of authorities having jurisdiction.
10. Change Orders received and implemented.
11. Construction Change Directive received.
12. Services connected and disconnected.
13. Equipment or system tests and startups.
14. Partial Completions and occupancies.
15. Substantial Completions authorized.

B) Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents prepare a detailed report.

Submit with a request for information on CSI Form 13.2A. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

11. SPECIAL REPORTS

A) General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

B) Reporting Unusual Events: When an event of an unusual and significant nature occurs alt Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

12. EXECUTION

A) CONTRACTOR'S CONSTRUCTION SCHEDULE

1. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.

a. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.

b. Contractor's Construction Schedule Updating: At intervals which shall correspond directly with each Certification for Payment, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly schedule progress meeting.

c. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made.

Issue updated schedule concurrently with the report or each such meeting.

d. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.

c. As the Work progresses, indicate Actual Completion percentage for each activity.

2. Distribution: Distribute copies of approved schedule to Architect/Engineer, Resident Inspector, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

    1. Post copies in Project meeting rooms and temporary field offices.
    2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION

SECTION 02100: CLEARING

1. SCOPE

A) Work included: Clear and grub the site as shown on the Drawings and Specified herein.

2. QUALITY ASSURANCE

A) Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

3. MATERIALS

A) Provide materials, not specifically described but required for proper completion of the work of this Section, as selected by the Contractor subject to the approval of the Architect.

4. SURFACE CONDITIONS

A) Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

5. DISPOSAL

A) General:
1. Remove brush, grass, roots, trash, and other material from clearing operations.
2. Dispose debris from the site in a legal manner.
3. Do not store or permit debris to accumulate on the job site.

B) Removal of Tree
1. Remove all trees and stumps from area to be occupied by roads and/or surfaced area. Removal of trees outside these areas shall only be done as noted on drawings and approved by the Architect. Remove without injury to trunks, interfering branches and roots of trees to remain in working area; perform cutting and trimmings as directed.
2. All brush, stumps, wood and other refuse from the trees shall be removed to disposal areas off the site.

6. PROTECTION OF TREES

A) General Protection - The Contractor shall be responsible for the protection of tops, trunks and roots of existing trees on project site that are to remain. Existing trees subject to construction damage shall be boxed, fenced or otherwise protected before any work is started; remove boxing when directed. Do not permit heavy equipment or stockpiles within branch spread. Remove interfering branches without injury to trunks and cover scars with tree paint.

B) Grading Around Trees (c) Where excavating, fill or grading is required within the branch spread of tress that are to remain, the work shall be performed as follows:

1. Trenching: When trenching occurs around trees to remain, the tree roots shall not be cut but the trench shall be tunneled under or around the roots by careful hand digging and without injury to the roots.
2. Raising Grades: When the existing grade at tree is below the new finished grade, and fill not exceeding 16" is required, clean washed gravel graded from 1" to 2" size shall be placed directly around the tree trunk. The gravel shall extend out from trunk on all sides a minimum of 18" and finish approximately 2" above the finished grade at tree. Install gravel before any earth fill is placed. New earth fill shall not be left in contact with the trunks of any trees requiring fill.
3. Raising Grades: When the existing grade of the tree is more than 16" below the new finished grade, the Contractor shall follow the special tree protection detail shown on the drawings. Strict adherence to this specification is necessary to insure no trees shall die due to suffocation and/or corroding of the roots due to improper protection in earth filling operations.
4. Lowering Grades: Existing trees in areas where the new finished grade is to be lowered, shall have regrading work done by hand to elevation as
Indicated. Roots as required shall be cut cleanly 3" below finished grade and scars covered with tree paint. Do not burn debris at the site.
7. STRIPPING TOPSOIL

A) Remove topsoil to its entire depth from the areas within areas to be occupied by roads, walks and utility lines. Pile topsoil in designated or approved locations where it will not interfere with buildings or utility operations. Areas to be stripped shall first be scraped clean of all brush, weeds,

grass, roots and other material that will interfere with lawn maintenance. Topsoil shall be reasonably free from subsoil, debris and stones larger than two (2) inches in diameter. (The stored topsoil shall be left in piles to be used for finished grading).

8. DISPOSITION OF UTILITIES

A) Rules and regulations governing the respective utilities shall be obtained in executing all work under this section. Coordinate with utility companies and agencies as required.

B) Active utilities shown on the drawings shall be adequately protected from damage and removed or relocated only as indicated or specified. Where active utilities are encountered but are not shown on the drawings, the Architect shall be advised; the work shall be adequately protected, supported, or relocated as directed by the Architect; the contract price will be adjusted for such additional work.

C) Inactive and abandoned utilities encountered in excavating and grading operations shall be reported to the Architect; they shall be removed, plugged or capped as directed by the Architect. In absence of specific requirements, plug or cap such utility lines as required by the local regulations.

D) Where utility cutting, capping, or plugging is required perform such work in accordance with requirements of the utility company or governmental agency having jurisdiction.

SECTION 02200: DEMOLITION

1. SCOPE

A) Carefully demolish and remove from the site the structures and items scheduled in the drawings and herein to be demolished and removed.

B) The demolition involves the removal of all those materials and elements marked in the drawings with the cross-hatched lines or marked with specific notes.

C) The aim of the demolition is to remove from the site and from the buildings all elements not intended to remain

2. QUALITY ASSURANCE

A) Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

3. SURFACE CONDITIONS

A) Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

4. WORK SEQUENCE

A) The work sequence is intended to proceed with the work in a systematic and orderly fashion establishing priorities by logic as described in numerical order below. It is also desirable to begin demolition from the roof down through specialized operation and using the same personnel in order to develop the necessary skills required, beginning again with the next operation at the roof and again working down and, hence repeating

in a systematic methodology. The stairs will be demolished toward the end to provide means of access to the upper floors.

B) Sequence

1. Submit detail Work Plan.
2. Construct Safety Fence 10'-0" from the exterior walls and along the total building perimeter.
3. Refer to construction drawing for Demolition Scope of Work.

5. SCAFFODING/SHORING/CHUTES

A) Contractor shall provide for adequate scaffolding during his operation. For the exterior more permanent scaffoldings should be used to cover the full height of the structure in vertical spans.

B) Adequate shoring shall be provided to secure the structural elements to remain and as deemed necessary by the Contractor to guarantee the safety of the employees. A shoring plan must be submitted for the approval of the Architect as part of the Work Plan. Sketches of the proposed shoring shall be submitted and no shoring work shall proceed until the Architect approves such sketches. Approval by Architect shall not be construed to affect the Contractor's responsibility for adequacy of the shoring. Shoring shall be arranged as to allow other items of work to proceed without interference.

C) Rubble disposal chutes and collection areas must be provided for the proper disposal of the demolished materials.

6. SERVICES

A) Utility services to the building will be eliminated. Contractor shall supply his own temporary services and Facilities.

7. EXECUTION

A) General

1. By careful study of the drawings and the existing buildings determine the location and extent of the demolition to the performed.
2. In company with the Architect, visit the site and verify the extent and location of demolition required.
   a. Carefully identify limits of demolition.
   b. Mark interface surfaces as required to enable workmen also to identify items to be removed and items to be left in place intact.
3. In all activities, comply with pertinent regulation of governmental agencies having jurisdiction.
4. Demolished material shall be considered to be property of the Contractor and shall be completely removed from the job site.
5. All re-usable items will remain property of the Owner. Contractor will coordinate with the Architect/Engineer for proper storage within the property.

B) General Demolition

1. Demolition shall be conducted using the softest possible methods of removal without disturbance of the existing structural elements to remain.
2. Although it have been attempted to mark in the drawings all major items to be removed, we definitely have ”not” inventorized all items many of which are remains of partitions, services or systems and are scattered throughout the surfaces. Such is the case of conduits, pipes, electric panels, hangers, chains, rods, fixtures, nails and other minor elements. Hence, as mentioned before, it is important that the Contractor visits the project, enters each room and verifies the amount and conditions of these elements, and quotes for the removal of all these items.

3. All service lines, panels, hanging brackets and remains of systems are to be removed. These in general have not been marked in the drawing.
4. Remains of metal fasteners into walls are to be removed, taking care not to damage the original plastered surfaces. These items include nails, screws, and pipes projecting.
5. Removed all existing fixtures not indicated to remain including its related service conduits, connections, fastening devices and valves. Fixtures terms apply to lighting fixtures and plumbing fixtures.
6. Existing doors, frames and windows in existing walls to remain must be removed.
7. Contractor will take precaution during demolition of existing systems. Any system to remain that is damaged during the demolition and construction works will be restored to original condition.
8. No structural member will be demolished unless the same is scheduled to be demolished in the drawings. Prior to demolition of the structural member, notify the Architect. Adjacent structural system shall be shored.
9. If the Contractor determines that a structural member necessary for the soundness of the existing building is scheduled to be demolished, he shall notify immediately the Architect and obtain a written authorization from the Architect to continue with the demolition.
10. Before proceeding with the demolition of the masonry walls, the Contractor shall shore the existing structural system to avoid any damage to this system.
11. Any section of the existing floor that must be demolished to permit the laying of pipes or proposed work will be restored to original conditions.
12. All existing bases at existing walls to remain will be completely removed. Surface will be skin coat cement plastered to provide a smooth surface.

13. All concrete or block walls demolition shall be done from existing finished floor elevation to structural slab soffit.
14. Block walls or concrete walls requiring demolition to permit the placing of pipes or proposed work will be restored to original conditions including patching and cement plastering the wall section demolished.
15. All existing concrete or block walls to remain but affected by demolition shall be finished with cement plaster.
16. Pipes, conduits and fittings inside walls to be demolished will be removed.
17. Modify existing openings in walls to remain to fit new doors, fixed glass or fenestration items. The opening shall be plastered along its entire perimeter.
18. All acoustical hung ceiling components including luminaries and air conditioning system accessories will be removed, unless indicated in the drawings to remain.
19. Holes in slab soffit and in beams to remain either existing or due to demolition will be patched, cement plastered and painted as per Architect instructions.
20. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site. Comply with the CEST Plan as detailed on the drawings.
21. In the event of demolition of items not so scheduled to be demolished, promptly replace such items to the approval of the Architect and at no additional cost to the Owner.
22. The Contractor shall dispose of demolished materials in an area outside the project premises and approved by the concerning government agencies. Disposal methods, routes, and destination to be presented in the Work Plan.
23. No explosives may be used on the site. No material will be burned on the site.

24. Contractor shall use equipment for the demolition that will produce the least possible vibration, and that will not damage existing structural elements to remain. With the Work Plan submit for approval proposed equipment.
25. If during the process of the demolition phase it is discovered that the equipment or method being used are weakening and producing new cracks in the structural element, the use of this equipment or method must be immediately discontinued.
26. When concrete structural elements must be separated from another structural element to remain, the demolition sequence must first separate and isolate the concrete elements to be removed from its location. Acceptable separation methods are electric sawing, consecutive drilling and hand chiseling. Pneumatic hammers may be used only after concrete is totally separated in order to break up removed elements into smaller pieces for disposal. Prior to beginning demolition process existing structural elements to remain must be shored.
27. Concrete block walls to be demolished shall be separated first from its supporting structural elements by the methods specified in Article 26 above. Avoid heavy impact on the structural elements to remain.
28. Concrete surfaces called in the drawings to be restored to original condition shall be treated with epoxy adhesive and vinyl concrete patcher by Bonsal to produce a smooth and straight surface.

8. PROTECTION

A) Protect all building components to remain until the building is retrofitted as called on another section of this specification. Maintain the components shored as the condition will required, and as informed by the Architect.

B) Remove from the site and dispose of demolished materials, debris and all other items not to be used in the construction. Disposal site shall be approved by all pertinent governmental agencies. Certify compliance that all the applicable laws and regulations were met when disposing of the material.

(A:63-demo)

SECTION 02201: SELECTIVE DEMOLITION

1. SCOPE

A) Carefully demolish and remove selected portions of building or structures and items scheduled in the drawings and herein to be demolished and removed.
B) The demolition involves the removal of all those materials and elements marked in the drawings with the crosshatched lines or marked with specific notes.
C) The aim of the demolition is to remove from the site and from the buildings all elements not intended to remain.

2. QUALITY ASSURANCE

A) Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.
B) For the refrigerant recovery of air conditioning units to be removed use certified by the Environmental Quality Board (EQB) and the Environmental Protection Agency (EPA) - approved certification program – Technicians.
C) Comply with EQB and EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of these agencies and any other Federal and State Agencies.
D) Contractor must comply with ANSI A 10.6 and NFPA 241.

3. SUBMITTALS

A) Schedule of Selective Demolition Activities: Indicate detailed sequence of selective demolition and removal work, with starting and ending dates for each activity, interruption of utility services, use of elevator and stairs, and locations of temporary partitions and means of egress.
B) Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations.

4. SURFACE CONDITIONS

A) Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to

timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

B) Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operation will not be disrupted or interrupted.

C) Conditions existing at time of inspection for bidding purpose will be maintained by Owner. Prospective Bidders must prepare his bid proposal base on existing conditions.

D) Notify Architect of discrepancies between existing conditions and construction drawings before proceeding with selective demolition.

E) If material suspected of containing hazardous materials is encountered, do not disturb; immediately notify Architect and Owner.

5. WORK SEQUENCE

A) The work sequence is intended to proceed with the work in a systematic and orderly fashion establishing priorities by logic as described in numerical order below. It is also desirable to begin demolition from the roof down through specialized operation and using the same personnel in order to develop the necessary skills required, beginning again with the next operation at the roof and again working down and, hence repeating in a systematic methodology. The stairs will be demolished toward the end to provide means of access to the upper floors.

B) Sequence

1. Submit detail Work Plan.
2. Construct Safety Fence 10'-0" from the exterior walls and along the total building perimeter. Refer to Section 01050 for fence requirements.
3. Refer to construction drawing for Demolition Scope of Work.

6. SCAFFODING/SHORING/CHUTES

B) Contractor shall provide for adequate scaffolding during his operation. For the exterior more permanent scaffoldings should be used to cover the full height of the structure in vertical spans.

C) Adequate shoring shall be provided to secure the structural elements toremain and as deemed necessary by the Contractor to guarantee the safety of the employees. Shoring plan must be submitted for the approval of the Architect as part of the

Work Plan. Sketches of the proposed shoring shall be submitted and no shoring work shall proceed until the Architect approves such sketches. Approval by Architect shall not be construed to affect the Contractor's responsibility for adequacy of the shoring. Shoring shall be arranged as to allow other items of work to proceed without interference.

D) Rubble disposal chutes and collection areas must be provided for the proper disposal of the demolished materials.

7. UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A) Existing Utilities Systems: Maintain utilities/systems indicated to remain and protect them against damage during selective demolition operations.

B) Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Arrange to shut off indicated utilities with utility companies.
2. If utilities/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

8. PREPARATION

A) Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B) Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C) Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

9. EXECUTION

A) General

1. By careful study of the drawings and the existing buildings determine the location and extent of the demolition to the performed.
2. In company with the Architect, visit the site and verify the extent and location of demolition required.
    a. Carefully identify limits of demolition.
    b. Mark interface surfaces as required to enable workmen also to identify items to be removed and items to be left in place intact.
3. In all activities, comply with pertinent regulation of governmental agencies having jurisdiction.
4. Demolished material shall be considered to be property of the Contractor and shall be completely removed from the job site.
5. All reusable items will remain property of the Owner. Contractor will coordinate with the Architect for proper storage within the property.
6. All existing air conditioning units shall remain property of the Owner. Contractor must deliver these units at a location to be informed by the owner within the Caguas Municipality.
7. Before commencing selective demolition verify that utilities that will be removed have been disconnected and capped.
8. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
9. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to the Architect.
10. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition operations.
11. Record existing conditions by use of measured drawings and
12. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

B) SELECTIVE DEMOLITION

1. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the work within limitations of governing regulations and as follows:

   a. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
   b. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
   c. Do not use cutting torches until work area is cleared of interiors, verify condition and contents of hidden space before starting flame-cutting operations.
   d. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
   e. Dispose of demolished items and materials promptly.

2. Removed and Salvaged Items:

   a. Clean salvaged items.
   b. Pack or crate items after cleaning. Identify contents of containers.
   c. Store items in a secure area until delivery to Owner.
   d. Transport items to Owner’s storage area within the Caguas Municipality.
   e. Protect items from damage during transport and storage.

3. Removed and Reinstalled Items:

   a. Clean and repair items to be re-used when called on the drawings to functional condition adequated for intended reuse. Paint equipment to match new equipment.
   b. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and

miscellaneous materials necessary to make item functional for use indicated.

4. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition. Cleaned and reinstalled in their original locations after selective demolition operations are complete.

C) SITE SELECTIVE DEMOLITION

1. Before proceeding with specified demolition, contractor must coordinate with the Municipality the disconnection of the existing building power system.

2. Demolition and any proposed relocation of existing utilities must be performed with the utmost care so as not to damage existing utilities to remain. Coordinate location of existing utilities with the Municipality before proceeding with demolition before demolishing existing concrete or asphalt pavement, to install utility. Perform cuts at both side of pavement with a saw to produce a straight line.

3. Location of all utilities shown on the drawings are approximate. Before commencing demolition and relocation works, contractor must establish in the field the exact locations of the water, sanitary, electrical and communication utilities. Before, commencing these works prepare a written report informing the architect its findings. Before proceeding with curb demolition, the contractor must determine existing curb alignment and proper staking displacement must be performed. Proposed concrete curb must follow existing curb alignment.

4. Existing sidewalk and pavement to remain must be protected. At conclusion of the construction, sidewalks must be clean and in similar conditions as existing conditions before construction. Existing conditions will be established by photographs (twenty photographs) taken by contractor at its expense. If photographs are not taken, original conditions will be as established by the Architect. Debris from demolition and material from excavation shall be transported to a site approved by

Environmental Quality Board (EQB). The transportation must be performed by a company authorized by the EQB. No material will be deposited within projects limits; Contractor must obtain from EQB a DS-3 Permit.

5. All underground structures affected by proposed construction must be completely demolished and space must be backfilled with material A-2-4 or better compacted to 95% of the maximum density of the backfill material as determined by AASHTO-T-180, Method D. The excavation must be closed prior to the contractor leaving the job at night. Soil shall be deposited in 0.15 meter layers.

6. The contractor shall be responsible at all times for the carrying out all excavation and demolition operation in a safe and prudent manner so that the workmen, the public and adjacent property will be protected from unreasonable hazard.

7. Soil or waste material from construction cannot be permitted to access storm system and exposed ground areas. Provide protection as indicated in the drawings.

8. Concrete pavement shown to be demolished shall be demolished for it his full depth.

9. All existing trees to remain in place, unless affected by proposed construction. Those trees to remain must be protected. Affected trees to be removed shall include all its roots.

D) General Demolition

1. Demolition shall be conducted using the softest possible methods of removal without disturbance of the existing structural elements to remain.

2. Although it have been attempted to mark in the drawings all major items to be removed, all of them have not been inventoried. Many of which are remains of partitions, services or systems and are scattered throughout the surfaces. Such is the case of conduits, pipes, electric panels, hangers, chains, rods, fixtures, nails and other minor elements. Hence, as mentioned before, it is important that the Contractor visits the project, enters each room and verifies the amount and conditions of these elements, and quotes for the removal of all these items.

3. All service lines, panels, hanging brackets and remains of systems are to be removed. These in general have not been marked in the drawing.
4. Remains of metal fasteners into walls are to be removed, taking care not to damage the original plastered surfaces. These items includes nails, screws, and pipes projecting.
5. Removed all existing fixtures including its related service conduits, connections, fastening devices and valves. Fixtures terms applies to lighting fixtures and plumbing fixtures.
6. Existing doors, frames and windows in existing walls to remain must be removed.
7. If during the construction any property is damaged or destroyed. The contractor shall at his own expense restore such property to a condition similar or equal to that existing before such damage or injury was done.
8. No structural member will be demolished unless the same is scheduled to be demolished in the drawings. Prior to demolition of the structural member, notify the Architect. Adjacent structural system shall be shored.
9. If the Contractor determines that a structural member necessary for the soundness of the existing building is schedule to be demolished, he shall notify immediately the Architect and obtain a written authorization from the Architect to continue with the demolition.
10. Before proceeding with the demolition of the mansonry walls, the Contractor shall shore the existing structural system to avoid any damage to this system.
11. Existing concrete floor to receive new finishing shall be fine grinded and water blasted to 5,000 psi to provide an exposed surface free of cement mortar, adhesive and dust.
12. Sections of existing concrete floor that must be demolished to permit the installation of underground pipe or conduit (water, waste, sanitary soil, electrical and gases) shall be cut with a saw to produce a straight line and for the full depth of concrete floor. The concrete slab must be restored to original condition with a minimum thickness of six (6″) inches. Reinforced with #4@12″ c.c both way. Trench must be backfilled with clean sand and concrete slab shall not be poured until pipe testing has been conducted.
13. All existing bases at existing walls to remain will be completely removed. Surface will be skin coat cement plastered to provide a smooth surface.

14. All concrete or block walls demolition shall be done from existing finished floor elevation to structural slab soffit.
15. Block walls or concrete walls requiring demolition to permit the placing of pipes or proposed work will be restored to original conditions including patching and cement plastering the wall section demolished.
16. All existing concrete or block walls to remain but affected by demolition shall be finished with cement plaster.
17. Pipes, conduits and fittings inside wall to be demolished shall be removed. If for the proper functioning of existing system to remain it is required to relocate the pipes, conduits and fittings it shall be performed at contractor's expense.
18. All exterior and interior exposed ducts, conduits pipes, boxes, panels and accessories must be removed, including fastening system, Holes and opening must be plugged with non-shrinkage grout (3,000 PSI) and cement plastered both sides.
19. New window opening to be cut with a saw to produce a straight cut. After cutting, then the section of the wall can be demolished.
20. Modify existing openings in walls to remain to fit new doors, fixed glass or fenestration items. The opening shall be reinforced with a concrete element as detail in drawings. The same shall be cement plastered.
21. All acoustical hung ceiling components including luminaries and air conditioning system accessories will be removed, unless indicated in the drawings to remain.
22. Existing concrete beams in which the reinforcing steel has been exposed shall be repaired as specified in Article 23.
23. Holes or spalling of concrete in slab soffit, concrete columns and beams to remain either existing or due to the demolition shall be repaired as follows:

    a. Surface must be chipped to sound concrete, minimum one (1") inch behind reinforcing steel.
    b. Sandblast reinforcing steel to remove corrosion and clean the surface.
    c. Apply SIKA ARMATEC 110 bonding bridge to exposed surface following manufacturer recommendations.
    d. Apply repair mortar similar or equal to SIKA TOP 121 PLUS.

24. Cracks in block and concrete walls must be sealed with an Elastomeric Sealant as follows:

    a. High preassure water blast the cracked surface to clean it and to provide a sound and free of dusts, etc. surface.
    b. Apply SIKAFLEX-1a By SIKA to the crack to fill the same to a ¼" minimum depth. The sealant shall be gunned into the crack.

25. Surfaces to receive cement plastering will be treated with bonding compound complying with ASTM C631 before applying plastering.
26. Non-shrinkage grout shall be equal or similar to Bonsal Non-Shrinkage Grout.
27. Vinyl concrete patching will be vinyl concrete patcher by Bonsal Construction products or an approved equal. Apply following manufacturer's recommendations.
28. Surface to receive vinyl concrete patcher must be water blasted to provide a clean surface. Before applying patcher, coat exposed surface with epoxy adhesive similar to SIKA 31 HI-MOD Gel following manufacturer's recommendations before applying patcher.
29. Epoxy adhesive shall be equal or similar to SIKADUR 32, HI-MOD by SIKA.
30. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site. Comply with the CES Plan to be prepared by Contractor.
31. In the event of an element not specified to be removed and the same is demolished, promptly replace such items to the approval of the Architect and at no additional cost to the owner.
32. The Contractor shall dispose of demolished materials in an area outside the project premises and approved by the concerning government agencies. Disposal methods, routes, and destination to be presented in the Work Plan.
33. No explosives may be used on the site. No material will be burned on the site.
34. Contractor shall use equipments for the demolition that will produce the least possible vibration, and that will not damage existing structural elements to remain. With the Work Plan submit for approval proposed equipment.
35. If during the process of the demolition phase it is discovered that the equipment or method being used are weaking and producing new cracks in the structural

element, the use of this equipment or method must be immediately discontinued.

36. When concrete structural elements must be separated from another structural elements to remain, the demolition sequence must first separate and isolate location. Acceptable separation methods are electric sawing, consecutive drilling and hand chiseling. Pneumatic hammers may be used only after concrete is totally separated in order to break up removed elements into smaller pieces for disposal. Prior to beginning demolition process existing structural elements to remain must be shored.
37. Concrete block walls to be demolished shall be separated first from its supporting structural elements by the methods specified in Article 36 above. Avoid heavy impact on the structural elements to remain.
38. Concrete surfaces called in the drawings to be restored to original condition shall be treated with epoxy adhesive and vinyl concrete patcher by Bonsal to produce a smooth and straight surface.

10. REGULATIONS

A) The demolition activity must comply with the following EQB regulations:

1. “Reglamento Para El Control De La Contaminación Atmosférica”.
2. “Reglamento Para El Manejo De Los Desperdicios Sólidos No Peligrosos”.

B) The contractor shall observe the following requirements during the demolition of the Project:

A. Particle Material Control:
   1. During the demolition of the existing structures and handling of the waste the same shall be kept wet.
   2. Trucks transporting waste material, debris and solid wastes must be kept covered and wetted during handling.

B. Debris and Solid Wastes:
   1. Project’s debris and waste materials must be disposed daily. At no time the waste will be stored in the project for more than one day.
   2. Debris and solid waste store in the project shall be kept wet to avoid it’s emission into the atmosphere.

3. Debris and solid wastes must disposed at site approved by the Environmental Quality Board (EQB). No material will be disposed within the owner property. Contractor must inform location where debris and solid wastes will be disposed.
4. Debris and solid wastes must be collected and transported by a company approved by the EQB. Contractor must provide evidence of this permit.

C. The Contractor will obtain the following permits from the Environmental Quality Board:
1. Permit for an Activity of Solid Wasted (DS-Form).
2. Permit for a Source of Fugitive Dust Emission (PFE-Form).

11. DISPOSAL OF DEMOLISHED MATERIALS

A) General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain owner's property, remove demolished materials from project site and legally dispose of them in an EQB approved landfill.

B) Burnign: Do not burn demolished materials.

C) Disposal: Transport demolished materials off owner's property and legally dispose or them in EQB approved landfill.

12. CLEANING

A) Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

13. PROTECTION

A) Protect all building components to remain until the building is retrofitted as called on another section of this specification. Maintain the components shored as the condition will required, and as informed by the Architect.

B) Disposal site shall be approved by all pertinent governmental agencies. Certify compliance that all the applicable laws and regulations were met when disposing of the material.

SECTION 03101: CAST IN PLACE CONCRETE

1 - SCOPE

A) These specifications cover cast-in-place structural concrete for use in buildings and appurtenances.

B) The provisions of these specifications shall govern where applicable (i.e., to conditions and types of work that occur on the particular job) except as otherwise provided in the contract documents. In case of conflicting requirements, the contract documents shall govern.

C) Related Work: This section is complemented by Sections 03102 to 03116 of this Division of these specificiations. Cast in place concrete must comply with all requirements of Sections 03102 to 03118 when applicable.

2 - LOADING AND SUPPORT OF CONCRETE

A) Construction loads shall not exceed the superimposed load which the member, with necessary supplemental support, is capable of carrying safely and without damage. The amount,method of distributing, and proposed supplemental support of loads during construction shall be acceptable.

3 - DEFINITIONS

A) The following definitions cover the meanings of certain words and terms as used in these specifications:
   1. Acceptable or permitted--Acceptable or permitted by the architect.
   2. ACI Concrete Field Testing Technician Grade I--A person who has demonstrated knowledge and ability by passing the American Concrete Institute--prescribed written and performance examinations, to perform and record the results of ASTM standard tests on freshly--mixed concrete, and to make cure test cylinders.

3. Architect --The accepting authority such as the architect, the engineer, the architectural firm, the engineering firm, the contracting officer, or other agency issuing project specifications and drawings and/or administering work under the contract documents.
4. Contract documents--The project drawings and project specifications.
5. Exposed construction--Exposed to public view.
6. Exposed to public view--Situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.
7. Lightweight concrete--Concrete internationally made to have low density by use of lightweight aggregate or a mixture of lightweight and normal weight aggregate, and usually required to have an air-dry unit weight less than 115 lb per cu ft.
8. Normal weight concrete--Concrete which density is not a controlling attribute, made with aggregates of the types covered by ASTM C 33, and usually having unit weights in the range of 135 to 160 lb per cu. ft.
9. Project drawings--The drawings with accompany project specifications and complete the descriptive information for construction work required or referred to in the project specifications.
10. Project specifications--The building specifications which employ ACI 301 by reference, and which serve as theinstrument for making the mandatory and optional selections available under these specifications and for specifying items not covered herein.
11. Required--Required by these specifications or the contract documents.
12. Submitted--Submitted to the architect for review.

B) Other words and terms use in these specifications are defined in Cement and Concrete Terminology (ACI 116R, which is also ACI SP-19).

4 - ASTM STANDARDS

American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

The standards of the American Society for Testing and Materials referred to in these specifications are listed below with their serial designation including the year of adoption or revision and are declared to be a part of these specifications, the same as if fully set forth herein:

A 82-85	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
A 184-86	Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
A 185-85	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
A 416-87a	Standard Specifiation for Uncoated Seven-Wire Stress-Relieved Steel Strand for Prestressed Concrete
A 421-80 (1985)	Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
A 496-85	Standard Specification for Steel Wire, Deformed for Concrete Reinforcement
A 497-86	Standard Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
A 615-87	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 616-87	Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
A 617-87	Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
A 706-86	Standard Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement
A 722-86	Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
A 767-85	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
A 775-86	Standard Specification for Epoxy-Coated Reinforcing Steel Bars
C 31-87a	Standard Method of Making and Curing Concrete Test Specimens in the Field
C 33-86	Standard Specification for Concrete Aggregates
C 39-86	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 42-84a	Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C 94-86b	Standard Specification for Ready-Mixed Concrete
C 109-86	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)

C 138-81	Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete
C 143-78	Standard Test Method for Slump of Portland Cement Concrete
C 144-87	Standard Specification for Aggregate for Masonry Mortar
C 150-86	Standard Specification for Portland Cement
C 171-69 (1986)	Standard Specification for Sheet Materials for Curing Concrete
C 172-82	Standard Method of Sampling Freshly Mixed Concrete
C 173-78	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
C 192-81	Standard Method of Making and Curing Concrete Test Specimens in the Laboratory
C 231-82	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C 260-86	Standard Specification for Air-Entraining Admixtures for Concrete
C 309-81	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C 330-87	Standard Specification for Lightweight Aggregates for Structural Concrete
C 387-87	Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
C 494-86	Standard Specification for Chemical Admixtures for Concrete
C 567-85	Standard Test Method for Unit Weight of Structural Lightweight Concrete
C 595-85	Standard Specification for Blended Hydraulic Cements
C 618-85	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
C 684-81	Standard Method of Making, Accelerated Curing, and Testing of Concrete Compression Test Specimens
C 685-86	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
C 881-78 (1983)	Standard Specification for Epoxy-Resin-Base Bonding System for Concrete
D 994-71	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
D 1752-84	Standard Specification for Performed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
E 329-77	Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction.

5 - OTHER REFERENCE STANDARDS AND PUBLICATIONS

The following standards and publications are referred to in these specifications.

A) American Concrete Institute, P.O. Box 19150, Detroit, MI 48219-0150:

SP- 15(89)	Field Reference Manual: Specifications for Structural Concrete for Buildings ACI 301-89 with selected ACI and ASTM references
ACI 116R-85 (SP-19)	Cement and Concrete Terminology
ACI 309R-87	Guide for Consolidation of Concrete
ACI 315-80 (Revised 1986)	Details and Detailing of Concrete Reinforcement
ACI 318-83 (Revised 1986)	Building Code Requirements for Reinforced Concrete
ACI CPI-87	Technician Workbook for ACI Certification of Concrete Field Testing Technician--Grade 1

B) American Welding Society, 550 N.W. LeJeune Road, P.O. Box 351040, Miami, FL 33135: "Structural Welding Code--Reinforcing Steel" (AWS D1.4--79).

C) Concrete Plant Manufacturers Bureau, 900 Spring Street, Silver Spring, MD 20910: "Concrete Plant Mixer Standards of the Plant Mixer Manufacturers Division," 1977.

D) National Ready Mixed Concrete Association, 900 Spring Street, Silver Spring, MD 20910: Check List for Certification of Ready Mixed Concrete Production Facilities, 1984.

E) American Association of State Highway and Transportation Officials, 444 North Capitol Street, N.W., Suite 225, Washington DC 20001: "Standard Method of Test for Sampling and Testing for Total Chloride Ion in Concrete" (AASHTO T260-84).

F) Concrete Reinforcing Steel Institute, 933 North Plum Grove Road, Schaumburg, IL 6019; Manual of Standard Pratice, 1986.

6 - FIELD REFERENCES

The contractor shall keep at least one copy of the reference listed below in his field office at all times.

A) "Specifications for Structural Concrete for Building (ACI 301-84) (Revised 1988) with Selected ACI and ASTM References," ACI Field Reference Manual, SP-15(88).

(server-admin-especificaciones-03-101)

SECTION 03102: MATERIALS FOR CONCRETE

1 - CEMENTS

A) Cement shall conform to one of the following standards:

1. Portland cement, ASTM C 150
2. Portland blast-furnance slag cement or portland-pozzolan cement, ASTM C 595
3. Slag cement, ASTM C 595

B) Unless otherwise permitted or required, cement shall be Type I or Type II, ASTM C 150

C) The cement used in the work shall correspond to the cement used when selecting concrete proportions.

2 - ADMIXTURES

A) Admixtures to be used in concrete, when required or permitted, shall conform to the following appropriate specifications:

1. Air-entraining admixtures, ASTM C 260
2. Water-reducing, retarding, and accelerating admixtures, ASTM C 494
3. Pozzolanic admixtures, ASTM C 618

C) Admixtures used in the work shall be of the same composition as those used in establishing the concrete proportions.

3 - WATER

Mixing water for concrete shall meet requirements of ASTM C 94.

4 - AGGREGATES

A) Aggregates for normal weight concrete shall meet the requirements for ASTM C 33 unless otherwise specified.

B) Aggregates for lightweight concrete shall be regarded as separate ingredients. Each size of coarse aggregate, as well as the combination of sizes when two or more are used, shall meet the appropriate grading requirements of the applicable ASTM specifications.

5 - STORAGE OF MATERIALS

A) Cement shall be stored in weathertight containers.

B) Aggregate stockpiles shall be ranged and used in such a manner to avoid excessive segregation and to prevent contamination with other materials or wiht other sizes of like aggregates. To insure that this condition is met, any test for determining conformance to requirements for cleaness and grading shall be performed on samples secured from the aggregates at the point of batching. Frozen or partially frozen aggregates shall not be used.

C) Stockpiles of natural or manufactured sand shall be allowed to drain to insure a relatively uniform moisture content throughout the stockpile.

D) Unless predampening is not considered desirable by the manufacturer or is considered impractical by the architect/engineer, dry lightweight aggregates shall be predampened as necessary. To prevent excessive variations in moisture content, predampened aggregates shall be allowed to remain in the stockpiles for a minimum of 12 hr before use.

E) Admixtures shall be stored in a manner that will avoid contamination, evaporation, or damage. For admixtures used in the form of suspensions or nonstable solutions, agitating equipment shall be provided to assure thorough distribution of the ingredients. Liquid admixtures shall be protected from freezing and from temperature changes which would adversely affect their characteristics.

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SECTION 03103: PROPORTIONING OF CONCRETE

1 - GENERAL

Concrete for all parts of the work shall be of the specified quality and capable of being placed without excessive segregation. When hardened, concrete shall develop all characteristics required by these specifications and the contract documents.

2 - STRENGTH

The specified compressive strength of the concrete f'c for each portion of the structure shall be as designated in the contract documents. Strength requirements shall be based on 28-day compressive strength unless a different test age is specified.

3 - WEIGHT

Lightweight concrete proportions shall be selected to meet the specified limit on maximum air-dry unit weight as measured in accordance with ASTM C 567.

4 - DURABILITY

A) Concrete of normal weight which will be subject to potentially destructive exposure (other than wear or loading) such as freezing and thawing, severe weathering or deicer chemicals shall be air-entrained and shall conform to the air content limits of Table A Measurement of air content meet the requirements of ASTM C 231, C 173, or C 138. The water-cement ratio shall not exceed 0.53 by weight. Lightweight concrete for such exposures shall contain 6 +/- 2 percent total air when the nominal maximum size of aggregate is greater than 3/8 in., or 7 +/- 2 percent total air when the nominal maximum size is 3/8 in. or less, as determined by the volumetric method, ASTM C 173. Proportions shall be selected to provide a specified strength f'c of 3000 psi or more.

TABLE A

Nominal maximum size of of coarse aggregate, in.*	Size Number	Total air content, percent by volume
3/8	8	6 - 10
1/2	7	5 - 9
3/4	67	4 - 8
1	57	3.5 - 6.5
1/2	467+	3 - 6
2	357+	2.5 - 5.5
3	---	1.5 - 4.5

*See ASTM C 33 for tolerances on oversize for various nominal maximum size designations.

+Aggregates of these maximum sizes are often batched as two size fractions in the correct proportions to yield the grading specified for Sizes 467 or 357. Size 467 would consist of Sizes 4 and 67 material and Size 357 a combination of Sizes 3 and 57.

B) Concrete of normal weight for portions of the structure required to be watertight shall have a water-cement ratio not exceeding 0.45 if exposure will be to fresh water or 0.45 for exposure to seawater. Lightweight concrete for such application shall be proportioned to produce a specified compressive strength f'c of at least 3750 psi for exposure to fresh water or 4000 psi for exposure to seawater.

C) For concrete that will be exposed to injurious concentrations of sulfate-containing or other chemically aggressive solutions, Type II or Type IV cement shall be used. For normal weight concrete in such application, the water-cement ratio shall not exceed 0.44 by weight; for lightweight concrete, the proportions shall be selected to produce a specified compressive strength of f'c of at least 4000 psi.

D) For prestressed concrete and for all concrete in which aluminum or galvanized metal is to be embedded, it shall be demonstrated by test that the mixing water of the concrete, including that contributed by the aggregates and any admixture used, will not contain a deleterious amount of chloride ion.

5 - SLUMP

Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 4 in. or less if consolidation is to be by vibration, and 5 in. or less if consolidation is to be by methods other than vibration. A tolerance of up to 1 in. above the maximum indicated shall be allowed for one batch in any five consecutive batches tested. Concrete of lower than usual slump may be used provided it is properly placed and consolidated. The slump shall be determined by ASTM C 143.

6 - MAXIMUM SIZE OF COARSE AGGREGATE

The nominal maximum size of the aggregate shall not be more than one-fifth of the narrowest dimension between sides of forms, one third of the depth of slabs, nor three-fourths of the minimum clear spacing between reinforcing bars. These limitations may be waived if, in the judgment of the Architect, workability and methods of consolidation are such that the concrete can be placed without honeycomb or voids. See ASTM C 33 for tolerances on oversize for various nominal maximum size designations.

7 - ADMIXTURES

If required or permitted, admixtures used shall be subject to the following limitations:

A) The amount of calcium chloride shall not exceed 2 percent by weight of cement. The amount of calcium chloride shall be determined by the method described in AASHTO T260.

B) For prestressed concrete and for all concrete which will contain embedments of or remain in contact with aluminum or galvanized metal, the limitation of Article 4-D shall apply unless protective measures acceptable to the Architect are provided.

C) All admixtures shall be used in accordance with the manufacturer's instructions except as otherwise specified.

8 - SELECTION OF PROPORTIONS

A) General:

Proposed concrete proportions shall be subject to acceptance by the architect based on demonstrated ability to produce concrete meeting all requirements of the specification.

1. Proportions of materials for concrete shall be established to provide:

   a) Adequate workability and proper consistency to permit concrete to be worked readily into the forms and around reinforcement without excessive segregation or bleeding under conditions of placement to be to be employed,
   b) Resistance to freezing and thawing and other aggressive actions, as required by Articles 4,
   c) Conformance with strength test requirements for Section 03117, and
   d) For concrete for floors, conformance with requirements of Article 14 for the class of floor required.

2. Concrete proportions shall be established on the basis of previous field experience or laboratory trial batches as specified in Article 9 with the materials to be employed in the work, or as specified in Article 10.

9 - PROPORTIONING ON THE BASIS OF PREVIOUS FIELD EXPERIENCE ON TRIAL MIXTURES

A) Determination of Standard:

1. Where a concrete production facility has a record, based on at least 30 consecutive strength tests or two groups of tests totaling at least 30 within the past 12 months, the standard deviation shall be calculated. The record of tests from which the standard deviation is calculated shall:

   a) Represent similar materials and conditions to those expected. Changes in materials and proportions within the test record shall not have been more closely restricted than those for the proposed work.

b) Represent concrete produced to meet a specified strength or a strength within 1000 psi of that specified for the proposed work.

c) Consist of at least 30 consecutive tests or two groups of consecutive tests totaling at least 30 tests, except as otherwise specified in Article 9-A-2.

The standard deviation "s" shall be calculated as

$$s = [Ó(Xi - \bar{X})^2 (N - 1)]1/2$$

where

Xi = the strength result of an individual test

$\bar{X}$ = the average of all individual tests in a series

N = number of tests in the series

If two test records are used to obtain a total of at least 30 tests, standard deviation used shall be the statistical average of the values calculated from each test record in accordance with

$$\bar{s} = \{[N1 - 1)(s1)2 + (N2 - 1)(s2)2 \div (N1 + N2)\}1/2$$

$\bar{s}$ = statistical average standard deviation where two test records are used to estimate the standard deviation

s1, s2 = standard deviations calculated from records of each of two test records 1 and 2 totaling 30 or more tests

N1, N2 = number of tests in test records 1 and 2 respectively

2. Where the concrete production facility does not have a sufficient number of test records to meet the requirements of Article 9-A-1 but does have a record based on 15 to 29 consecutive tests, the standard deviation calculted from these tests may be used if, after calculation, the value is first multiplied (increased) by the appropriate factor given in

Table B. To be acceptable under this section the test record must meet the stipulations in Articles 9-A-1-a and 9-A-1-b and represent consecutive tests. Further, the record of 15 to 29 tests shall cover a class of concrete furnished for a period of not less than 60 days.

Table B - Increased standard deviation when more than 15 tests are available

Number of tests*	Factor for increasing the standard deviation+
15	1.16
20	1.08
25	1.03
30 or more	1.00

*Interpolate linearly for intermediate number of tests.

+The increased standard deviation is used to calculate required average strength from Articles 9-A-2.

3. When the concrete production facility does not have a record of tests for calculation of standard deviation meeting the requirements of Article 9-A-1 or 9-A-2, the requirements of Article 9-A-2 shall govern.

B) Determination of Required Average Compressive Strength

1. The required average compressive strength for used as the basis for selection of concrete proportions shall be the larger of Eq.(1) or (2) using a standard deviation s (or s) calculated in accordance with Article 9-A-1 ir 9-A-2.

$f_{cr} \geq f'_c + 1.34s$ - Eq. 1

$f_{cr} \geq f'_c + 2.33s - 500$ - Eq. 2

where

f'_c = specified compressive strength of concrete, psi
f_{cr} = required average compressive strength of concrete, psi
s = standard deviation, psi

2. When a suitable record of tests is not available to establish a standard deviation, the required average strength shall exceed f'c by the amount given in Table C.

Table C - Required average strength when suitable data are not available to establish a standard deviation

Specified strength f'c psi	Required average strength, psi
Less than 3000	f'c + 1000
3000 to 5000	f'c + 1200
Over to 5000	f'c + 1400

C) Documentation of Average Strength:

1. Documentation that the proposed concrete proportions will produce an average strength equal to or greater than the required average strength determined in accordance with Article 9-B shall consist of the strength test record, or several strength test records from field tests, or shall consist of results from suitable trial mixtures.

2. When field test records are used to demonstrate that the proposed concrete proportions will produce the required average strength determined in accordance with Article 9-B, the records shall represent similar material to those proposed, and similar conditions to those expected. Changes in materials, conditions, and proportions within the test record shall not have been more closely restricted than those for the proposed work. For the purpose of documenting the average strength potential, test records consisting of less than 30 but not less than 10 consecutive tests may be used provided the test record encompasses a period not less than 60 days. The required concrete proportions may be established by interpolation between the strengths and proportions of two or more test records, each of which meets the other requirements of this section.

3. When an acceptable record of field test results is not available, concrete proportions shall be established based on trial mixtures meeting the following restrictions:
   a) The combination of materials shall be those proposed work.
   b) Trial mixtures having proportions and consistencies suitable for the proposed work shall be made using at least three different water-cement ratios or, for lightweight concrete, cement contents that will produce a range of strengths encompassing those required for the proposed work.
   c) Trial mixtures shall be designed to produce a slump within 1 in. of the maximum permitted, and for air-entrained concrete, within 0.5 percent of the maximum allowable air content. The temperature of freshly mixed concrete in trial mixtures shall be reported.
   d) For each proposed mixture, at least three compressive test cylinders for each age shall be made and cured in accordance with ASTM C 192. For normal, heavyweight, and mass concrete, each change of water-cement ratio shall be considered a new mixture. The cylinders shall be tested for strength in accordance with ASTM C 39 at 28 days or at a specified earlier or later age.
   e) From the results of these cylinder tests, a curve shall be plotted showing the relationship between compressive strength and either the water-cement ratio for normal, heavyweight, or mass concrete content for lightweight concrete.
   f) From this curve, the water-cement ratio for normal, heavyweight, or mass concrete, or cement content for lightweight concrete for the concrete to be used in the proposed work, shall be selected to produce the average strength required Article 9-B. The cement content and mixture pro portions to be used shall be such that the selected water-cement ratio or cement content is not exceeded when slump is the maximum permitted. Control in the field shall be based on maintenance of proper cement content, slump, and air content.

10- PROPORTIONING BASED ON EMPIRICAL DATA

A) When acceptable field test records or trial mixture data are not available and if accepted by the Architect, the water-cement ratio shall not exceed the appropriate values shown in Table D. Table D does not apply when suitable field test records or trial mixture information is available and proportions are established under Articles 9. This is not applicable to the following:

1. Concrete containing admixtures other than those used exclusively for the purpose of entraining air.
2. Prestressed concrete.
3. Concrete designed for specific strengths f'c in excess of 4000 psi.

Table D - Maximum permissible water-cement ratios for concrete when strength data from field experience or trial mixtures are not available

	Maximum permissible water-cement ratio by weight*	
Specified strength f'c psi	Non-air-entrained concrete	Air-entrained concrete+
4000	0.44	0.35
3750	0.48	0.38
3500	0.51	0.40
3000	0.58	0.46
2500	0.67	0.54

*Including free surface moisture on aggregate and liquid admixtures.
+Conforming to limits of Table 3.4.1.

11- REDUCTION OF THE REQUIRED AVERAGE STRENGTH

A) After sufficient data become available during construction, the amount by which the average strength must exceed the specified strength f'c may be reduced if accepted by the Architect. Conditions requiring an increase are covered in Section 03117. This reduction is valid:

1. If 30 or more test results are available and the average of those test results exceeds that required by Articles 9-B-1 using the standard deviation calculated from the results, or
2. If more than 15, but less than 30, test results are available results exceeds that required by Article 9-B-1 using the standard deviation increased by the factor in Table B.

12- LIGHTWEIGHT CONCRETE

A) Ability of the selected proportions to meet specified limits for air-dry unit weight shall be verified by tests made in accordance with ASTM C 567. The air-dry unit weight shall be correlated with the fresh unit weight of the same concrete to permit use of the latter as the basis for acceptance during construction.

13- DRY-PACKAGED MIXTURES

A) Dry-packaged concrete conforming to ASTM C 387 may be used provided the product intended for use can be shown to be capable of providing the concrete characteristics required.

14- CONCRETE FOR FLOORS

A) These criteria apply only when structural or durability requirements of Article 2 and Article 4 do no neccesitate higher strength or cement content.

B) Concrete floors are classified according to Table E, depending upon the proposed usage of the floor. The slump and 28-day strength shall conform to the appropriate limits of Table E. Proportions shall be selected to provide the indicated values of f'c in accordance with Articles 9 and 10, but the cement content shall not be less than shown in Table F, except as permitted by Article 14-C. For all floor clases, the required compressive strength at 3 days shall be 1800 psi and shall be based on criteria of Article 9.

Table E - Floor classifications

Class	Usual traffic	Typical Uses	28-day compressive strength	Required for normal weight concrete, in.* Maximum slump
1	Light	Residential	3000	4
2	Foot	Offices, churches, schools, hospitals, residences	3500	4
3	Light foot and pneumatic wheels	Drives, garage floors, and sidewalks for residences	3500	4
4	Foot and pnneumatic wheels	Light industrial, commercial	4000	3
5	Foot and wheels-abrasive wear	Single-course industrial, integral topping	4500	3
6	Foot and steel-tire vehicles severe abrasion	Two-course heavy industrial, bonded topping	Base 3500 Topping+ 5000-8000++	4

*Slump not exceed 3 in. if structural lightweight aggregates are used. All values of slump shown are working maxima and may be exceeded by up to 1 in. for individual field batches as prescribed in Article 5.

+Maximum aggregate size not more than one-third the thickness of topping.

++The strength required will depend on the severity of abrasive exposure. The range shown will cover most situations.

Table F - Minimum cement requirements for concrete used in floors

Nominal maximum size of aggregate, in.	Cement, lb. per cu yd
1 1/2	470
1	520
3/4	540
1/2	590
3/8	610

C) Concrete containing less cement than shown in Table F may be used when it is demonstrated to the satisfaction of the Architect that the proposed proportions will produce concrete of acceptable finishing properties, durability, surface hardness, and appearance and will meet the strength requirements of Article 9-B) at both 3 and 28 days. The contractor shall provide a trial slab to permit evaluation of finishing properties, hardness, and appearance of the concrete proposed for use. The slab shall be at least 8 x 8 ft, of the specified thickness, and made with the proposed materials and proportions, using equipment and personnel comparable with those to be employed on the work. The concrete used shall be demonstrated to be capable of being finished to the satisfaction of the architect/engineer at a slump not exceeding that given in Table E.

(server-admin-especificaciones-03-103)

SECTION 03104: FORMWORK

1 - GENERAL

A) Forms shall be used, wherever necessary, to confine the concrete and shape it to the required dimensions. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall have sufficient rigidity to maintain specified tolerances.

B) Additional formwork requirements for concrete are specified in Section 03104, Finishing of Formed Surfaces; Section 03111, Slabs; Section 03113, Architectural Concrete; and Section 03115, Prestressed Concrete.

C) Earth cuts shall not be used as forms for vertical surfaces unless required or permitted.

D) Shop drawings for formwork including the location of shoring and reshoring shall be submitted for review as required by the contract documents.

2 - DESIGN AND INSTALLATION OF FORMWORK

A) The design and engineering of the formwork, as well as its construction, shall be responsibility of the Contractor.

B) The formwork shall be designed for loads and lateral pressure and for design considerations, wind loads, allowable stresses, and other applicable requirements of the controlling local building code.

C) Requirements for facing materials are given in Section 03110, Finishing of Formed Surfaces. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.

D) Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Chamfer strips shall be placed in the corners of forms to produce beveled edges on permanently exposed surfaces. Interior corners on such surfaces and the edges of formed joints will not require beveling unless required by the contract documents.

E) To maintain the specified tolerance, the formwork shall be cambered to compensate for anticipated deflections in the formwork prior to hardening of the concrete.

F) Positive means of adjustment (wedges or jacks) of shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Forms shall be securely braced against lateral deflections.

G) Temporary openings shall be provided at the base of column forms and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.

H) Form accessories to be partially or wholly embedded in the concrete, such as ties and hangers, shall be of a commercially manufactured type. Nonfabricated wire shall not be used.

Form ties shall be constructed so that the ends or end fasteners can be removed without causing appreciable spalling at the surface of the concrete.

After the ends or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 diameters or twice the minimum dimension of the tie from the formed surface of concrete to be permanently exposed to view except that in no case shall the distance be less than 3/4 in. When the formed surface of the concrete is not be permanently exposed to view, form ties may be cut off flush with the formed surfaces.

I) At construction joints, contact surface of the form sheating for flush surfaces exposed to view shall overlap the hardened concrete in the previous placement by not more than 1 in. The forms shall be held against the hardened concrete to prevent offsets or loss of mortar at the construction joint and to maintain a true surface.

J) Wood forms for wall openings shall be constructed to facilitate loosening, if necessary, to counteract swelling of the forms.

K) Wedges used for final adjustment of the forms prior to concrete placement shall be fastened in position after the final check.

L) Formwork shall be so anchored to shores or other supporting surfaces or members that upward or lateral movement of any part of the formwork system during concrete placement will be prevented.

M) Runways for moving equipment shall be provided with struts or legs, shall be supported directly on the formwork or structural member, and shall not rest on the reinforcing steel.

3 - TOLERANCES

A) Unless otherwise specified by the Architect, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits listed in Table G.

B) The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project sufficient control points and bench marks to be used for reference purposes to check tolerances.

C) Regardless of the tolerances listed in Table G, no portion of the building shall extend beyond the legal boundary of the project.

Table G--Tolerances for Formed Surfaces

1. Variation from plumb:	
A. In the lines and surfaces of columns, piers, walls, and arrises:	
In any 10 ft of length	1/4 in.
Maximum for the entire length	1 in.
B. For exposed corner columns, control-joint grooves, and other conspicuous lines:	
In any 20 ft length	1/4 in.
Maximum for the entire length	1/2 in.
2. Variation from the level or from the grades specified in the contract documents:	

A. In slab soffits, ceilings, beam soffits and in arrises, measured before removal of supporting shores
   - In any 10 ft of length . . . . . 1/4 in.
   - In any bay or in any 20 ft. length . . . . 3/8 in.
   - Maximum for the entire length . . . . . 3/4 in.

B. In exposed lintels, sills, parapets horizontal grooves, and other conspicuous lines:
   - In any bay or in 20 ft. length . . . . . 1/4 in.
   - Maximum for the entire length . . . . . 1/2 in.

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3. Variation of the linear building lines from established position in plan and related position of columns, walls, and partitions:
   - In any bay . . . . . 1/2 in.
   - In any 20 ft. length . . . . . 1/2 in.
   - Maximum for the entire length . . . . . 1 in.

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4. Variation in the sizes and location of sleeves, floor openings, and wall openings . . . . . +/- 1/4 in.

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5. Variation in cross-sectional dimensions of columns and beams and in thickness of slabs and walls:
   - Minus . . . . . 1/4 in.
   - Plus . . . . . 1/2 in.

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6. Footings*

A. Variations in dimensions in plan:
   - Minus . . . . . 1/2 in.
   - Plus . . . . . 2 in.

B. Misplacement or eccentricity:
   2 percent of the footing width in the direction of misplacement but not more than . . . . . 2 in.

TABLE G (CONT.) - TOLERANCE FOR FORMED SURFACES

C. Thickness:	
Decrease in specified thickness	5 percent
Increase in specified thickness	No limit
7. Variation in steps:	
A. In a flight of stairs:	
Rise	+/- 1/8 in.
Tread	+/- 1/8 in.
B. In consecutive steps:	
Rise	+/- 1/16 in.
Tread	+/- 1/ 8 in.

* Tolerance apply to concrete dimensions only, not to positioning of vertical reinforcing steel, dowels, or embedded items.

D) Permissible variations from plum and designated building lines for portions of buildings more than 100 ft. above the ground shall be as specified in the contract documents.

4 - PREPARATION OF FORM SURFACES

A) All surfaces of forms and embedded materials shall be cleaned of all accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

B) Unless otherwise specified or accepted, surfaces of forms shall be treated as follows:

1. Before placing the reinforcing steel or the concrete, the surfaces of the forms shall be covered with an acceptable coating material that will effectively prevent absorption of moisture, prevent bond with the concrete, and not stain the concrete surfaces. A field applied form release agent or sealer of acceptable type or factory applied nonabsorptive liner may be used.

2. Excess form coating material shall not stand in puddles in the forms nor shall such coating come in contact with hardened concrete against which fresh concrete is to be placed.

5 - REMOVAL OF FORMS

A) When repair of surface defects or finishing is required at an early age, forms shall be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations.

B) Top forms on sloping surfaces of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surfaces shall be performed at once and be followed by the specified curing.

C) Wood forms for wall openings shall be loosened as soon as this can be accomplished without damage to the concrete.

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

E) Forms and shoring in the formwork used to support the weight of concrete in beams, slabs, and other structural members shall remain in place until the concrete has reached the minimum strength specified in the contract documents for removal of forms and shoring.

F) When shores and other vertical supports are so arranged that the non-load-carrying form-facing material may be removed without loosening or disturbing the shores and supports, the facing material may be removed at an earlier age as specified or permitted.

6 - RESHORING

A) When reshoring is permitted or required, the operations shall be planned in advance and shall be subject to approval. While reshoring is under way, no live load shall be permitted on the new construction.

B) In no case during reshoring shall concrete in beam, slab, column or any other structural member be subjected to combined dead and construction loads in excess of the loads permitted by the Architect for the developed concrete strength at the time of reshoring.

Reshores shall be placed immediately after stripping operations are complete, but in no case later than the end of the working day on which stripping occurs.

Reshores shall be tightened to carry their required loads without overstressing the construction. Reshores shall remain in place until tests representative of the concrete being supported have reached the specified strength, f'c or the strength specified in the contract documents for removal of reshores.

C) Floors supporting shores under newly placed concrete shall have their original supporting shores left in place or shall be reshored. The reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one half of the capacity of the shoring system above. The reshores shall be located directly under a shore position above, unless other locations are acceptable.

D) In multistory buildings the reshoring shall extend over a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads in such a manner that the design superimposed loads of the floors supporting shores are not exceeded.

7 - REMOVAL STRENGTH

When removal of formwork or reshoring is based on the concrete reaching a specified strength, the concrete shall be presumed to have reached this strength when either of the following conditions has been met:

A) When test cylinders, field cured along with the concrete they represent, have reached the strength specified for removal of formwork or reshoring. Except for the field curing and age at test, the cylinders shall be molded and tested as specified in Section 03116, Testing.

B) When the concrete has been cured in accordance with the provisions of Section 03112 for the same length of time as the age at test of laboratory-cured cylinders which reached the specified strength. The length of time the concrete has been cured in the structure shall be determined by the cumulative number of days or fractions thereof, not necessarily consecutive, during which the temperature of the air in contact with the concrete is above 50 F and the concrete has been damp or thoroughly sealed from evaporation and loss of moisture.

(server-admin-especificaciones:03-104)

SECTION 03105: REINFORCEMENT

1 - GENERAL

Placing drawings showing all fabrication dimensions and location for placing reinforcement and bar supports shall be submitted for review and acceptance. Acceptance shall be obtained before fabrication.

2 - REINFORCEMENT

A) Reinforcing bars:

All reinforcing bars shall be deformed except spirals, which may be plain bars. Reinforcing bars shall be the grades required by the contract documents and shall conform to one of the following specifications:

1. ASTM A 615.
2. ASTM A 616 including supplementary requirement S1.
3. ASTM A 167.
4. ASTM A 706.

B) Coated reinforcing bars:

When specified, coated reinforcing bars shall be zinc-coated (galvanized) or epoxy-coated. The reinforcing bars to be coated shall conform to Article 2-A.

1. Zinc-coated (galvanized) reinforcing bars shall conform to ASTM A 767. Supplementary requirements S1 and S2 shall apply when fabrication after galvanization includes cutting and bending. Supplementary requirement S2 shall apply when fabrication after galvanization includes only bending.
2. Epoxy-coated reinforcing bars shall conform to ASTM A 775.
3. Repair of damaged zinc coating, when required, shall be made with a zinc-rich formulation conforming to ASTM A 767. Repair shall be done in accordance with the material manufacturer's recommendations.
4. Repair of damaged epoxy coating, when required, shall be made with patching material conforming to ASTM A 775. Repair shall be done in accordance with the material manufacturer's recommendations.

C) Bar mats:

1. Bar mats shall be of the clipped type conforming to ASTM A 184 and shall be fabricated from reinforcing bars that conform to Article 2-A.
2. Bar mats may be fabrictaed from zinc-coated (galvanized). Nonmetallic clips may be used. Coating damage at the clipped intersections shal be repaired in accordance with Article 2-B-3.
3. Bar mats may be fabricated from epoxy-coated reinforcing bars. Metal clips shall be epoxy-coated. Nonmetallic clips may be used. Coating damage at the clipped intersections shall be repaired in accordance with Article 2-B-4.

D) Wire:

1. Wire shall be smooth or deformed wire as indicated on the contract documents.
2. Smooth wire shall conform to ASTM A 82.
3. Deformed wire shall conform to ASTM A 496, size D4 and larger.

E) Welded wire fabric:

1. Welded wire fabric shall be fabricated from smooth or deformed wire and shall conform to the wire size and wire spacing required or indicated on the contract documents. Welded wire fabric shall conform to one of the following specification:
2. ASTM A 185, except welded intersections shall be spaced not farther apart than 12 in. in the direction of the principal reinforcement.
3. ASTM A 497, except welded intersections shall be spaced not farther apart than 16 in. in the direction of the principal reinforcement.

F) Spirals:

Spirals may be fabricated from reinforcing bars or wire.

3 - WIRE BAR SUPPORTS

Unless otherwise specified or permitted, wire bar supports shall be in accordance with Class 1, maximum protection, or Class 2, moderate protection in Chapter 3 of Manual of Standard Practice by the Concrete Reinforcing Steel Institute.

4 - WELDING

A) When required or permitted, all welding of reinforcing bars shall conform to AWS D1.4. Unless otherwise accepted, welding of crossing bars (tack welding) for assembly of reinforcement is prohibited.

B) Welding of wire to wire, and of wire or welded wire fabric to reinforcing bars or structural steels, shall conform to applicable provisions of AWS D1.4 and supplementary requirements specified by the Architect.

C) After completion of welding on zinc-coated (galvanized) or epoxy-coated reinforcing bars, coating damage shall be repaired in accordance with Articles 2-B-3 or 2-B-4 respectively. All welds, and all steel splice members when used to splice bars, shall be coated with the same material used for repair of coating damage.

5 - FABRICATION

All reinforcement shall be bent cold unless otherwise permitted.

6 - FABRICATING AND PLACING TOLERANCES

A) Reinforcing bars shall be fabricated in accordance with the standard fabricating tolerances in Fig. 4 and 5 of ACI 315.

B) Reinforcement shall be placed to the following tolerances:

	Tolerances in.
Clear distance	
To formed soffit	- 1/4
To other formed surfaces	+/- 1/4
Minimum spacing between bars	- 1/4
Clear distance from unformed surface to top reinforcement	
Members 8 in. deep or less	+/- 1/4
Members more than 8 in. deep but less than 24 in. deep	- 1/4, + 1/2
Members 24 in. deep or greater	- 1/4, + 1
Uniform spacing of bars, but the required number of bars shall not be reduced	+/- 2

Uniform spacing of bars, but the required number of stirrups and ties, shall not be reduced	+/- 1
Longitudinal locations of bends and ends of reinforcement	
General	+/- 2
Discontinuous ends of members	+/- 1/2
Length of bar laps	- 1 1/2
Embedded length	
For bar sizes No. 3 through 11	- 1
For bar sizes No. 14 and 18	- 2

C) When it is necessary to move bars to avoid interference with other reinforcement, conduits, or embedded items exceeding the specified placing tolerances, the resulting arragement of bars shall be subject to acceptance.

7 - PLACING

A) Minimum concrete cover for reinforcement, except for extremely corrosive atmosphere, other severe exposures, or fire protection, shall be as follows:

	Minimum cover, in.
Concrete deposited against the ground . . .	3
Formed surfaces exposed to weather or in contact with the ground	
For bar sizes No. 6 or larger	2
For bar sizes No. 5 and smaller, and W31 or D31 wire and smaller	1 1/2
Formed surfaces not exposed to weather or not in contact with the ground	
Beams, girders, and columsn	1 1/2
Slabs, walls, and joists	
For bar sizes No. 11 or smaller	3/4
For bar sizes No. 14 and 18	1 1/2

1. For bundled bars, minimum concrete cover shall be equal to the equivalent diameter of the bundle but need not be greater than 2 in.; except for concrete deposited against and permanently in contact with the ground, minimum cover shall be 3 in. The equivalent diameter of the bundle shall be based on a single bar of a diameter derived from the equivalent total area.

B) All reinforcement, at the time concrete is placed, shall be free of mud, oil, or other materials that may adversely affect or reduce the bond. Reinforcement with rust, mill scale, or a combination of both shall be considered satisfactory provided the minimum dimensions, weight, and height of deformations of a hand-wire-brushed test specimen are not less than the applicable ASTM specification requirement.

C) All reinforcement shall be supported and fastened before concrete is placed and shall be secured against displacement within the tolerances permitted in Article 6-B.

1. Unless otherwise indicated in the contract documents, reinforcement supported from the ground or mud mat shall rest on precast concrete blocks not less than 4 in. 2 and having a compressive strength equal to or greater than the specified compressive strength of the concrete being placed. Other means of support may be used if accepted.
2. Reinforcement supported from formwork shall rest on bar supports made of concrete, metal, plastic, or other acceptable materials. Where the concrete surface will be exposed to the weather in the finished structure, the portions of all bar supports within 1/2 in. of the concrete surface shall be non-corrosive or protected against corrosion.
3. Zinc-coated (galvanized) reinforcing bars supported from formwork shall rest on galvanized wire bar supports coated with dielectric material, or on bar supports made of dielectric material or other acceptable materials. All other reinforcement and embedded steel items in contact with galvanized reinforcing bars, or within a minimum clear distance of 2 in. from galvanized reinforcing bars unless otherwise required or permitted, shall be galvanized.
4. Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable materials. Wire bar supports shall be coated with dielectric material for a minimum distance of 2 in. from the point of with the epoxy-coated reinforcing bars. Reinforcing bars used as support bars shall be epoxy-coated. In walls having epoxy-coated reinforcing bars, spreader bars where specified shall be epoxy-coated. Propietary

combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion-resistant material or coated with dielectric material.

5. Zinc-coated (galvanized) reinforcing bars shall be fastened with zinc-coated tie wire, or nonmetallic-coated tie wire, or other acceptable materials.
6. Epoxy-coated reinforcing bars shall be fastened with nylon-, epoxy-, or plastic-coated tie wire; or other acceptable materials.

D) Welded wire fabric for slabs on grade shall extend to within 4 in. of the concrete edge. Welded wire fabric may extend through the contraction joints. Welded wire fabric shall be adequately supported during placing of concrete to assure proper positioning in the slab.

E) Templates shall be furnished for placement of all column dowels unless otherwise permitted.

F) All splices shall be as indicated on the contract documents unless otherwise permitted. Mechanical connections for reinforcing bars may be used when accepted. After installation of mechanical connections on zinc-coated (galvanized) or epoxy-coated reinforcing bars, coating damage shall be repaired in accordance with Articles 2-B-3 and 2-B-4, respectively. All parts of mechanical connections used on coated bars, including steel splice sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damage.

G) Bending or straightening or bars partially embedded in concrete shall not be permitted except when specifically accepted. Bending shall be in accordance with Articles 7-G-1 and 7-G-2

1. The minimum inside bend diameters shall conform to the requirements of Table H, unless otherwise permitted. In addition, the beginning of the bend shall not be closer to the concrete surface than the minimum diameter of bend. Preheating, if required, shall be in accordance with Articl 7-G-2. The following requirements shall be adhered to for individual bar sizes:

Bar size	Bend requirements
No.3 through No.5	Bars may be cold bent the first time. Cold bend bars only when temperature is above 32 F. Preheating is required for subsequent straightening or bending.
No.6 and larger	Preheating is required.

Table H - Minimum diameter of bend

Bar size	Minimum diameter
No.3 through 8	6 bar diameters
No.9, 10, 11	8 bar diameters
No.14 and 18	10 bar diameters

2. Preheating prior to bending or straightening, when required, shall be in accordance with the following requirements:

   a. Preheating may be applied by any method which does not harm the bar material or cause damage to the concrete.
   b. The preheat shall be applied to a length of bar equal to at least 5 bar diameters each way from the center of the bend except that preheat shall not extend below the surface of the concrete. The temperature of the bar at the concrete interface shall not exceed 500 F.
   c. The preheat temperature shall be 1100 to 1200 F.
   d. The preheat temperature shall be maintained until bending or straightnening is complete.
   e. The preheat temperature shall be measured by temperature measurement crayons, contact pyrometer, or other acceptable method.
   f. Heated bars shall not be artificially cooled until the material temperature is less than 600 F.

3. Repair of damaged coating--When zinc-coated (galvanized) or epoxy-coated reinforcing bars are field bent, coating damage shall be repaired in accordance with Articles 2-B-3 or 2-B-4, respectively.

H) Zinc-coated (galvanized) reinforcing bars:

Coating damage due to handling, shipping, and placing shall be repaired in accordance with Article 2-B-3.

I) Epoxy-coated reinforcing bars:

Equipment for handling epoxy-coated reinforcing bars shall have protected contact areas. Bundles of coated bars shall be lifted at multiple pickup points to prevent bar-to-bar abrasion from sags in the bundles. Coated bars or bundles of coated bars shall not be dropped or dragged. Coated bars shall not be cause for rejecting epoxy-coated reinforcing bars. Coating damage due to handling, shipping, and placing need not be repaired in cases where the damaged area is 0.1 in.2 or smaller. Damaged areas larger than 0.1 in.2 shall be repaired in accordance with Article 2-B-4. The maximum amount of damage including repaired and unrepaired areas shall not exceed 2 percent of the surface area of each bar.

(server-admin-especificaciones-03-105)

SECTION 03106: JOINTS AND EMBEDDED ITEMS

1 - CONSTRUCTION JOINTS

A) Joints not indicated on the contract documents shall be located and constructed to minimize the impact on the strength of the structure. Joint types and locations shall be acceptable to the Architect. In general, joints shall be located near the middle of the spans of slabs, beams, and girders unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.

B) All reinforcement shall be continued across joints. Longitudinal keys at least 1 1/2 in. deep shall be provided in all joints in walls and between walls and slabs or footings. Other keys and inclined dowels shall be acceptable to the Architect.

C) The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed prior to placing adjoining concrete.

D) When required or permitted, bond shall be obtained by one of the following methods:

1. The use of an acceptable adhesive.
2. The use of an acceptable chemical retarder which delays but does not prevent setting of the surface mortar. Retarded mortar shall be removed within 24 hr after placing to produce a clean exposed aggregate bonding surface.
3. Roughening the surface of the concrete in an acceptable manner which will expose the aggregate uniformly and will not leave latiance, loosened particles of aggregate or damaged concrete at the surface.

2 - EXPANSION JOINTS

A) Reinforcement or other embedded metal items bonded to the concrete (except dowels in floors bonded on only one side of joints) shall not be permitted to extend continuously through any expansion joint.

B) Premolded expansion joint filler shall be of the type required by the contract documents and shall conform to ASTM D 994, ASTM D1751 or ASTM D 1752.

3 - WATER STOPS

A) The material, design, and location of waterstops in joints shall be as indicated in the contract documents.

B) Each piece of premolded waterstop shall be of maximum practicable length in order that the number of end joints will be held to a minimum.

C) Joints at intersections and at ends of pieces shall be made in the manner most appropriate to the material being used. Joints shall develop effective watertightness fully equal to that of the continuous waterstop material, shall permanently develop not less than 50 percent of the mechanical strength of the parent section, and shall permanently retain their flexibility.

4 - OTHER EMBEDDED ITEMS

A) All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support shall be placed prior to concreting.

B) All sub-contractors whose work is related to the concrete or must be supported by it shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is placed.

5 - PLACING EMBEDDED ITEMS

A) Expansion joint material, waterstops, and other embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

(server-admin-especificaciones-03-106)

SECTION 03107: PRODUCTION OF CONCRETE

1 - READY-MIXED CONCRETE PRODUCED BY ON-SITE VOLUMETRIC BATCHING AND CONTINUOUS MIXING

A) Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C 94, except as otherwise provided in this section. Plant equipment and facilities shall conform to "Certification of Ready Mixed Concrete Production Facilities (Checklist with Instructions)" of the National Ready Mixed Concrete Association.

B) Concrete produced by on-site volumetric batching and continuous mixing shall be batched and mixed in accordance with and shall conform to all requirements of ASTM C 685.

2 - ALL OTHER CONCRETES

A) Batching:

1. Scales for weighting concrete ingredients shall be accurate when in use within +/- 0.4 percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.
2. Operation of batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances:

Cement	+/-1 percent
Water	+/-1 percent
Aggregates	+/-2 percent
Admixtures	+/-3 percent

3. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue to flow for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.

B) Mixing:

1. The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within the specified mixing

time, and of discharging the concrete without harmful segregation. The mixer shall bear a manufacturer's rating plate indicating the rated capacity and the recommended revolutions per minute and shall be operated in accordance therewith.

2. Mixers with a rated capacity of 1 cu yd or larger shall conform to the requirements of the Plant Mixer Manufacturers Division of the Concrete Plant Manufacturers Bureau.
3. Except as provided in Architect 2-B-4 below, batches of 1 cu yd or less shall be mixed for not less than 1 min. The mixing time shall be increased 15 sec for each cubic yard or fraction thereof of additional capacity.
4. Shorter mixing time may be permitted provided performance tests made in accordance with Section 9.3.2 of ASTM C 94 indicate that the time is sufficient to produce uniform concrete.
5. Controls shall be provided to insure that the batch cannot be discharged until the required mixing time has elapsed. At least three-quarters of the required mixing time shall take place after the last of the mixing water has been added.
6. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixer blades shall be replaced when they have lost 10 percent of their original height.

3 - CONTROL OF ADMIXTURES

A) Air-entraining admixtures, calcium, chloride, and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an acceptable mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if so recommended by the manufacturer.

B) If two or more admixtures are used in the concrete, they shall be added separately to avoid possible interaction that might interfere with the efficiency or either admixture or adversely affect the concrete.

C) Addition of retarding admixtures shall be completed within 1 min after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first.

4 - LIGHTWEIGHT CONCRETE

A) Lightweight aggregate concrete shall be batched and mixed as recommended by the producer of the aggregate except that, if procedures are recommended which are at variance with these specifications, they shall be acceptable.

B) Concrete made with lightweight aggregate that has been shown to absorb less than 2 percent by weight during the first hour after inundation based on test of a sample from the field-conditioned supply shall be batched and mixed as required in Articles 1,2 and 3.

C) Concrete made with lightweight aggregates not conforming with the absorption limit of Article 4-B shall be batched and mixed as follows:

1. The aggregate shall be added to approximately 80 percent of the mixing water and mixed for a minimum of 1 1/2 min (15 revolutions in a truck mixer).
2. Then the admixtures, if any, the entire weight of cement, and the withheld portion of mixing water shall be added in the order named, and mixing completed in accordance with Article 1, 2-B whichever is applicable.

D) Acceptance of lightweight concrete in the field shall be based on fresh unit weight measured in accordance with Section 5.2 of ASTM C 567. The nominal fresh unit weight shall be that corresponding to the specified maximum air-dry unit weight calculated from the formula in Section 5.6 of ASTM C 567. When the nominal fresh unit weight varies more than 2 lb per cu ft from the required weight, the mixture shall be adjusted as promptly as conditions will permit to bring the unit weight to the desired level. Fresh unit weight of any batch shall not vary more than 3 lb per cu ft from the desired level.

5 - TEMPERING AND CONTROL OF MIXING WATER

A) Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall be discarded and shall not be retempered.

B) When concrete arrives at the project with slump below that suitable for placing, as indicated by the specifications, water may be added only if neither the maximum slump is exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. An addition of water above that permitted by the limitation on water-cement ratio shall be accompanied by a quantity of cement sufficient to maintain the proper water-cement ratio. Such addition shall be acceptable to the Architect or his representative.

6 - WEATHER CONDITIONS

A) Cold weather:

1. In cold weather, the temperature of the concrete when delivered at the site of the work shall conform to the temperature limitations in Table I.
2. If water or aggregate is heated above 100 F, the water shall be combined with the aggregate in the mixer before cement is added. Cement shall not be mixed with water or with mixtures of water and aggregate having a temperature greater than 100 F.

Table I --Temperature limitations on concrete when delivered at site of work

	Minimum concrete temperature, deg F	
Air temperature, deg F	For sections with least dimension less than 12 in.	For sections with least dimension 12 in. or greater
30 to 45	60	50
0 to 30	65	55
Below 0	70	60

B) Hot weather:

The ingredients shall be cooled before mixing, or flake ice or well-crushed ice of a size that will melt completely during mixing may be substituted for all or part of the mixing water if, due to high temperature, low slump, flash set or cold joints are encountered.

SECTION 03108: PLACING OF CONCRETE

1 - PREPARATION BEFORE PLACING

A) Hardened concrete and foreign materials shall be removed from the inner surfaces of the conveying equipment.

B) Formwork shall be completed; snow, ice and water shall be removed; reinforcement shall be secured in place; expansion joint material, anchors, and other embedded items shall be positioned; and the entire preparation shall be accepted.

C) Semiporous subgrades shall be sprinkled sufficiently to eliminate suction and porous subgrades shall be sealed in an acceptable manner (Section 03111).

D) Concrete shall not be placed on frozen ground.

2 - CONVEYING

A) Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of ingredients and in a manner which will assure that the required quality of the concrete is maintained.

B) Conveying equipment shall be acceptable and shall be of a size and design such that detectable setting of concrete shall not occur before adjacent concrete is placed. Conveying equipment shall be cleaned at the end of each operation or work day. Conveying equipment and operations shall conform to the following additional requirements:

1. Truck mixers, agitators, and nonagitating units and their manner of operation shall conform to the application requirements of ASTM C 94.
2. Belt conveyors shall be horizontal or at a slope which will not cause excessive segregation or loss of ingredients. Concrete shall be protected against undue drying or rise in temperature. An acceptable arrangement shall be used at the discharge end to prevent segregation. Mortar shall not be allowed to adhere to the return length of the belt. Long runs shall be discharged into a hopper or through a baffle.

3. Chutes shall be metal or metal-lined and shall have a slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20 ft long and chutes not meeting the slope requirements may be used provided they discharge into a hopper before distribution.
4. Pumping or pneumatic conveying equipment shall be of suitable kind with adequate pumping capacity. Pneumatic placement shall be controlled so that segregation is not apparent in the discharged concrete. The loss of slump in pumping or pneumatic conveying equipment shall not exceed 2 in. Concrete shall not be conveyed through pipe made of aluminum or aluminum alloy.

3 - DEPOSITING

A) General:

Concrete shall be deposited continuously, construction joints shall be located as indicated on the contract documents or as permitted. Placing shall be carried on at such a rate that the concrete which is being integrated with fresh concrete is still plastic. Concrete which has partially hardened or has been contaminated by foreign materials shall not be deposited. Temporary spreaders in forms shall be removed which the concrete placing has reached an elevation rendering their service unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior acceptance has been obtained.

B) Placing:

Placing of concrete in supported elements shall not be started until the concrete previously placed in columns and walls is no longer plastic and has been in place at least two hours.

C) Segregation:

Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Concrete shall not be subjected to any procedure which will cause segregation.

D) Consolidation:
All concrete shall be consolidated by vibration, spading, rodding, or forking so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Internal vibrators used shall be the largest size and the most powerful that can be used properly in the work, as described in Table 5.1.5 of ACI 309R. They shall be operated by competent workmen. Use of vibrators to transport concrete within forms shall not be allowed. Vibrators shall be inserted and withdrawn at points approximately 18 in. apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not sufficient to cause segregation, generally from 5 to 15 sec. A spare vibrator shall be kept on the job site during all concrete placing operations. Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented if necessary by spading to work the coarse aggregate back from the formed surface.

4 - PROTECTION

A) Unless adequate protection is provided and acceptance is obtained, concrete shall not be placed during rain, sleet, or snow.

B) Rainwater shall not be allowed to increase the mixing water nor to damage the surface finish.

C) Placing temperature
When the temperature of the surrounding air is expected to be below 40 F during placing or within 24 hr thereafter, the temperature of the plastic concrete, as placed, shall be no lower than 55 F for sections less than 12 in. in any dimension nor 50 F for any other sections. The temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints and should not exceed 90 F. When the temperature of the concrete exceeds 90 F, precautionary measures acceptable to the Architect shall be put into effect. When the temperature of the steel is greater than 120 F, steel forms and reinforcement shall be sprayed with water just prior to placing the concrete.

5 - BONDING

A) When specified, the surface of joints shall be prepared in accordance with one of the methods specified in Section 03106.

B) The hardened concrete of construction joints and of joints and of joints between footings and walls or columns and beams or floors they support, joints unexposed walls and all others not mentioned below shall be dampened (but not saturated) immediately prior to placing of fresh concrete.

C) The hardened concrete of horizontal construction joints in exposed work; horizontal construction joints in the middle of beams, girders, joists, and slabs; and horizontal construction joints in work designed to contain liquids shall be dampened (but not saturated) and then thoroughly covered with a coat of cement grout of similar proportions to the mortar in the concrete. The fresh concrete shall be placed before the grout has attained its initial set.

D) Joints receiving an adhesive shall have been prepared and adhesive applied in accordance with the manufacturer's recommendations prior to placing of fresh concrete.

6 - CONCRETING UNDER WATER

A) When required or permitted, concrete shall be deposited under water by an acceptable method in a way that the fresh concrete enters the mass of previously placed concrete from within, causing water to be displaced with minimum disturbance at the surface of the concrete.

(server-admin-especificaciones-03-108)

SECTION 03109: REPAIR OF SURFACE DEFECTS IN CONCRETE

1 - GENERAL

A) Repair with portland cement mortar:

1. When acceptable to the Architect, all honecombed and other defective concrete shall be removed down to sound concrete. If chipping is necessary the edges shall be perpendicular to the surface or slightly undercut. No featheredges will be permitted. The area to patched and an area at least 6 in. wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using a mix of approximately 1 part cement to 1 part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surface.
2. The patching mixture shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2 1/2 parts sand by damp loose volume. White portland cement shall be substituted for a part of the gray portland cement on exposed concrete to produce a color matching the color of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.
3. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as the leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least 1 hr before being finally finished. The patched area shall be kept damp for 7 days. Metal tools shall not be used in finishing a patch in a formed wall which will be exposed.

B) Repair materials and procedures, other than those specified in Article 1-A, may be used for repair when acceptable. Materials include but are not limited to:

1. Shotcrete.
2. Commercial patching products, including:
   a) Latex-modified portland cement mortar.
   b) Latex bonding agents if not re-emulsifiable when subsequently exposed to moisture.
   c) Epoxy mortars and compounds that are moisture insensitive with an epoxy binder that conforms to ASTM C 881, Type III.

      Caution shall be exercised when using these materials with regard to possible color changes from weathering and delamination due to different coefficients of thermal expansion.

C) When required for exposed concrete that will be left unpainted, color tests shall be made with patching methods and materials to determine color compability.

3 - TIE HOLES

Tie holes shall be plugged unless stainless steel, noncorrosive, or acceptably coated ties are used. When portland cement mortar is used for plugging, tie holes shall be cleaned and dampened prior to patching. When surface is to be textured for architectural appearance by sandblasting or bushhammering, minor defects and tie holes shall be repaired to match the adjoining concrete in color and texture when viewed from a distance of 5 ft. Other materials used for plugging the holes shall be subject to acceptance by the Architect and shall be applied in accordance with the manufacturer's written recommendations, where applicable.

4 - REMOVAL OF STAINS, RUST, EFFLORESCENCE, AND SURFACE DEPOSITS

Stains, rust, efflorescent, and surface deposits considered objectionable by the Architect shall be removed by methods acceptable to the Architect.

SECTION 03110: FINISHING OF FORMED SURFACES

1 - GENERAL

A) After removal of forms the surfaces of concrete shall be given one or more the finishes specified below in location designated by the contract documents or as specified in Article 4.

B) When finishing is required to match a small sample furnished to the Contractor, the sample finish shall be reproduced on an area at least 100 sq ft in an inconspicuous location designated by the Architect before proceeding with the finish in the specified location.

2 - AS-CAST FINISHES

A) Rough form finish:

No selected form facing materials shall be specified for rough form finish surfaces. Tie holes and defects shall be patched. Fins exceeding 1/4 in. in height shall be chipped off or rubbed off. Otherwise, surfaces shall be left with the texture imparted by the forms.

B) Smooth form finish:

The form facing material shall produce a smooth, hard, uniform texture on the concrete. It may be plywood, tempered concrete-form-grade hardboard, metal, plastic, paper, or the accecptable material capable of producing the desired finish. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection (see Table G for tolerances). Material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. Tie holes and defects shall be patched. All fins shall be completely removed.

C) Special architectural finishes

Textured finish, exposed aggregate finish, and aggregate transfer finish are architectural concrete finishes and shall be produced in accordance with the requirements of Section 03113, Architectural Concrete.

3 - RUBBED FINISHES

The following finishes shall be produced on concrete with a smooth form finish (Article 2-B). Where smooth rubbed finish is to be applied, the forms shall have been removed and necessary patching completed as soon after placement as possible without jeopardizing the structure.

A) Smooth rubbed finish

Smooth rubbed finish shall be produced on newly hardened concrete no later than the day following form removal. Surfaces shall be wetted and rubbed with carborundum brick or other abrasive until uniform color and texture are produced. No cement grout shall be used other than the cement paste drawn from the concrete itself by the rubbing process.

B) Grout cleaned finish

No cleaning operations shall be undertaken until all contiguous surfaces to be cleaned are completed and accessible. Cleaning as the work progresses shall not be permitted. Mix 1 part portland cement and 1 1/2 parts fine sand with sufficient water to produce a grout having the consistency of thick paint. White portland cement shall be substituted for a part of the gray portland cement in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch. Wet the surface of the concrete sufficiently to prevent absorption of water from the grout and apply the grout uniformly with brushes or a spray gun. Immediately after applying the grout, scrub the surface vigorously with a cork float or stone to coat the surface and fill all air bubbles and holes. While the grout is still plastic, remove all excess grout by working the surface with a rubber float, burlap, or other means. After the surface withens from drying (about thirty minutes at normal temperatures), rub vigorously with clean burlap. The finish shall be kept damp for at least 36 hours after final rubbing.

C) Cork floated finish:

Remove forms at an early stage, within 2 to 3 days of placement where possible. Remove ties. Remove all burns and fins. Mix one part portland cement and one part fine sand with sufficient water to produce a stiff mortar. Dampen wall surface. Apply mortar with firm rubber float or with trowel, filling all surface voids. Compress mortar into voids using a slow-speed grinder or stone. If the mortar surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with a fog sprayer. Produce the final texture with a cork float using a swirling motion.

4 - UNSPECIFIED FINISH

If the finish is not designated in the contract documents, the following finishes shall be used as applicable:

A) Rough form finish:

For all concrete surfaces not exposed to public view.

B) Smooth form finish:

For all concrete surfaces exposed to public view.

5 - RELATED UNFORMED SURFACES

Top of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to a texture reasonably consistent with that of the formed surfaces. Final treatment on formed surfaces shall continue uniformly accross the unformed surfaces.

(server-admin-especificaciones-03-110)

SECTION 03111: SLABS

1. GENERAL

Concrete for slabs shall be proportioned in accordance with Section 0303 to meet the requirements for the class of floor designated in the contract documents.

2. PREPARATION OF SUBGRADE FOR SLABS ON GROUND

A) The subgrade shall be well drained and of adequate and uniform loadbearing capacity. The minimum in-place density of the subgrade soils shall be as required in the specifications. The bottom of an undrained granular base course shall not be lower than the adjacent finished grade.

B) The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing it shall be raised and maintained above 50 F long to remove all frost from the subgrade.

C) The subgrade shall be moist at the time of concreting. If necessary, it shall be dampened with water in advance of concreting, but there shall be no standing water on the subgrade nor any muddy or soft spots when the concrete is placed.

3. EDGE FORMS AND SCREEDS

A) Edge forms and intermediate screed strips shall be set accurately to produce the designated elevations and contours of the finished surface, and shall be sufficiently strong to support vibrating screeds or roller pipe screeds if the nature of the finish specified requires the use of such equipment. The concrete surface shall be aligned to the contours of screed strips by the use of strike-off templates or acceptable compacting type screeds.

B) When formwork is cambered, screeds shall be set to a like camber to maintain the proper concrete thicknesses.

4. PLACEMENT

A) Mixing and placing shall be carefully coordinated with finish. Concrete shall not be placed on the subgrade or forms more radidly than it can be spread, straightedged, and darbied or bull floated. These operations must be performed before bleeding water has an opportunity to collect on the surface.

B) To obtain good surfaces and avoid cold joints, the size of finishing crews shall be planned with due regard for the effects of concrete temperature and atmospheric conditions on the rate of hardening of the concrete. If construction joints become necessary, they shall be constructed as required in Section 03106.

5. JOINTING

Joints in slabs on grade shall be located and detailed as indicated in the contract documents. If saw-cut joints are required or permitted, cutting shall be timed properly with the set of concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent aggregates being disloged by the saw. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking.

6. CONSOLIDATION

Concrete in slabs shall be in thoroughly consolidated. Internal vibration shall be used in beams and girders of framed slabs, and along the bulkheads of slabs on grade. Consolidation of slabs shall be obtained with vibrating screeds, roller pipe screeds, internal vibrators, or other acceptable means.

7. FINISHES (SEE ARTICLE 9 FOR DEFINITIONS OF TOLERANCE CLASSES)

A) Scratched finish:

After the concrete has been placed, consolidated, struck off, and leveled to a Class C tolerance, the surface shall be roughened with stiff brushes or rakes before the final set.

7. FINISHES (SEE ARTICLE 9 FOR DEFINITIONS OF TOLERANCE CLASSES) (CONT.)

B) Floated finish:

After the concrete has been placed, consolidated, struck off, and leveled, the concrete shall not be worked further until ready for floating. Floating with a hand float or with a bladed power trowel equipped with float shoes, or with a powered disc float shall begin when the water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation. During or after the 10-ft straightedge applied at not less than two different angles. All high spots shall be cut down and all low spots filled during this procedure to produce a surface within Class B tolerance throughout. The slab shall then be refloated immediately to a uniform sandy texture.

C) Troweled finish:

The surface shall first be float finished as specified in Article 7-B. It shall next be power troweled, and finally hand troweled. The first troweling after power floating shall produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Additional troweling shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be essentially free of trowel marks, uniform in texture and appearance and shall be plane to a Class A tolerance, except tolerance for concrete on metal deck shall be Class B. On surface intended to support floor coverings, any defects of sufficient magnitude to show through the floor covering shall be removed by grinding.

D) Broom or belt finish:

Immediately after the concrete has received a float finish as specified in Article 7-B, it shall be given a coarse transverse scored texture by drawing a broom or burlap belt across the surface.

7. FINISHES (SEE ARTICLE 9 FOR DEFINITIONS OF TOLERANCE CLASSES) (CONT.)

E) Heavy-duty topping for two-course slabs:

1. The topping mixture shall be composed of materials selected to impart heavy-duty wearing properties to the finished slab. Materials selected shall be acceptable to the Architect.
2. The base slab shall be placed and screeded 3/4 to 1 in. below the required finish surface and consolidated. The concrete shall not be worked further until ready for the next operation.
3. Topping placed on the same day as base slab. When bleed water has disappeared and the surface of the base slab will support a man without appreciable indentation, the topping mixture shall be spread, compacted, floated, checked for trueness of surface, and finished in the manner specified above for floated finish (see Article 7-B) or troweled finish (Article 7-C) except that power-driven floats shall be of the impact type.
4. Topping placement deferred. As soon as the base slab has partially set, the surface shall be brushed with a coarse wire broom to remove laitance and scratch the surface. The base slab shall be wet cured a minimum of three days. The scratched base slab shall be protected from contamination until time to place the topping. Prior to placement of topping, the base slab shall be thoroughly cleaned and dampened but left free of standing water. Immediately before the topping is place, a coat of bonding grout prepared in accordance with Section 03109 shall be scrubbed into the surface; it shall not be allowed to set or dry before the topping is placed. Bonding agents other than cement grout may be used if acceptable. The topping mixture shall be placed, compacted, and finished as described in Article 9.

F) "Dry shake" finish"

If a "dry shake" application of a selected metallic or mineral aggregate is specified, the aggregate, selected or acceptable to the Architect, shall be blended with portland cement in the proportions recommended by the manufacture of the aggregate. The surface shall be given a float finish in accordance with Article 7-B. Approximately two-thirds of the blended material for required coverage shall be applied to the surface by a method that insures even coverage without segregation.

7. FINISHES (SEE ARTICLE 9 FOR DEFINITIONS OF TOLERANCE CLASSES) (CONT.)

Floating shall begin immediately after application of the first "dry shake." After this material has been embedded by floating, the remainder of the blended material shall be applied to the surface at right angles to the previous application. The second application shall be heavier in any areas not sufficiently covered by the first application. A second floating shall follow immediately. After the selected material has been embedded by the two floatings, the operation shall be completed with a broomed, floated, or troweled finish, as designated in the contract documents.

G) Non-slip finish:

Where the contract documents require a nonslip finish, the surface shall be given a "dry shake" application, as specified above, of crushed ceramically bonded aluminum oxide or other specified selected abrasive particles. The rate of application of such material shall be not less than 25 lb per 100 sq ft.

H) Topping for two-course slab not intended for heavy duty service:

Preparation of base slab, selection of topping material, mixing, placing, consolidating and finishing operations shall be as specified in Article 7-E above, except that the aggregate need not be selected for special wear resistance.

I) Exposed aggregate finish:

Immediately after the surface of the concrete has been leveled to a Class B tolerance in accordance with Article 7-B and surface water has disappeared, aggregate of color and size (usually 3/8 to 5/8 in.) selected by the Architect shall be spread uniformly over the surface to provide complete coverage to the depth of a single stone.

7. FINISHES (SEE ARTICLE 9 FOR DEFINITIONS OF TOLERANCE CLASSES) (CONT.)

1. The spread of selected aggregate shall be embedded into the surface by light tamping and the surface shall be floated until the embedded stone is fully coated with mortar and the surface has been brougth to a true plane within Class B tolerance. Exposure of the aggregate shall start after the matrix has hardened sufficiently to prevent dislogdement of the aggregate. Water, in abundant quantities but without force, shall be allowed to flow over the surface of the concrete while the matrix encasing the selected aggregate is removed by brushing with a fine bristle brush. This operation shall continue until the selected aggregate is uniformly exposed but not dislodged.
2. An acceptable chemical retarder sprayed onto the freshly floated surface may be used to extend the working time for exposure of aggregate.

8. UNSPECIFIED FINISH

When type of finish is not specified in the contract documents, the following finishes shall be used as applicable:

1. Scratched finish--For surfaces intended to receive bonded applied cementitious applications.
2. Floated finish--For surfaces intended to receive roofing, waterproofing membranes, or sand bed terrazzo.
3. Troweled finish--For floor intended as walking surfaces or for reception of floor coverings.
4. Broom or belt finish--For sidewalks and garage floors and ramps.
5. Nonslip finish--For exterior platforms, steps, and landings; and for exterior and interior pedestrian ramps.

9. FINISHING TOLERANCES

A) Finishes with Class A tolerances shall be true planes within 1/8 in. in 10 ft, as determined by a 10-ft straightedge placed anywhere on the slab in any direction.

B) Finishes with Class B tolerances shall be true planes within 1/4 in. in 10 ft, as determined by a 10-ft straightedge placed anywhere on the slab in any direction.

9. FINISHING TOLERANCES (CONT.)

C) Finishes with Class C tolerances shall be true planes within 1/4 in. in 2 ft as determined by a 2-ft straightedge placed anywhere on the slab in any direction.

(server-admin-especificaciones-03-111)

SECTION 03112: CURING AND PROTECTION OF CONCRETE

1 - GENERAL

Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures, and mechanical injury, and shall be maintained with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of tbe cement and hardening of the concrete. The materials and methods of curing shall be subject to acceptance.

2 - PRESERVATION OF MOISTURE

A) For concrete surfaces not in contact with forms, one of the following procedures shall be applied immediately after completion of placement and finishing:

1. Ponding or continuous sprinkling.
2. Application of absorptive mats of fabric kept continuously wet.
3. Application of sank kept continuously wet.
4. Continuous application of steam (not exceeding 150 F) or mist spray.
5. Application of waterproof sheet materials, conforming to ASTM C 171.
6. Application of other acceptable moisture-retaining covering.
7. Application of a curing compound conforming to ASTM C 309. The compound shall be applied in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. It shall not be used on any surface against which ad ditional concrete or other material is to be bonded unless it is proven that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications.

B) Moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal the concrete shall be cured until the end of the time prescribed in Article 8-C by one of the methods of Article 2-B.

C) Curing in accordance with Article 8-A or 8-B shall be continued for at least 7 days in the case of all concrete except high-early-strength concrete for which the period

shall at least 3 days. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, moisture retention measures may be terminated when the average compressive strength has reached 70 percent of the specified strength, f'c. Moisture retention measures may also be terminated when the temperature of the concrete is maintained at least 50 F for the same length of time that laboratory-cured cylinders, representative of the concrete-in-place, require to achieve 85 percent of f'c. If one of the curing procedures of Article 2-B-1 through 2-B-4 is used initially, it may be replaced by one of the other procedures of Article 2-A any time after the concrete is 1 day old provided the concrete is not permitted to become surface dry during the transition.

3 - TEMPERATURE, WIND, AND HUMIDITY

A) Cold water:

When the mean daily outdoor temperature is less than 40 F, the temperature of the concrete shall be maintained between 50 and 70 for the required curing period of Article 2-C. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not used during the first 24 hr unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.

B) Hot weather:

When necessary, provision for windbreaks, shading, for spraying, sprinkling, ponding, or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.

C) Rate of temperature change

Changes in temperatures of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 5 F in any 1 hr or 50 F in any 24-hr period.

4 - PROTECTION FROM MECHANICAL INJURK

A) During the curing period, the concrete, shall be protected from damaging mechanical disturbances, such as load stresses, heavy stock, and excessive vibration. All finished concrete surfaces shall be protected from damage by construction equipment, materials, or methods, by application of curing procedures, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete.

(server-admin-especificaciones-03-112)

SECTION 03116: TESTING OF CONCRETE

1 - GENERAL

Concrete materials and operations will be tested and inspected as the work progresses. Failure to detect any defective work or material shall not in any way prevent later rejection when such defect is discovered nor shall it obligate the Architect for final acceptance.

2 - TESTING AGENCIES

A) The required testing services of Article 3, 4, and 5 shall be performed by the testing agency selected by the Contractor and approved by the Architect.

B) The testing services of this Article will be performed by a testing agency acceptable to the Architect at the Contractor's expense.

C) All testing agencies shall meet the requirements of ASTM E 329.

D) Tests of concrete required in Article 3 shall be made by an ACI Concrete Field Testing Technician Grade 1, or equivalent. Equivalent certification programs shall include requirements for written and performance examinations as stipulated in ACI publication CPI.

3 - TESTING SERVICES

The following testing services shall be performed by the designated agency:

A) Review and/or check-test the Contractor's proposed materials for compliance with the specifications.

B) Review and check-test the Contractor's proposed mixture design when required by the Architect.

C) Secure production samples of materials at plants or stockpiles during the course of the work and test for compliance with the specifications.

D) Conduct strength tests of the concrete during construction in accordance with the following procedures:

1. Secure composite samples in accordance with ASTM C 172. Each sample shall be obtained from a different batch of concrete on a random basis, avoiding any selection of the test batch other than by a number selected at random before commencement of concrete placement.
2. Mold and cure three specimens from each sample in accordance with ASTM C 31. Any deviations from the requirements of this Standard shall be recorded in the test report.
3. Test specimens in accordance with ASTM C 39. Two specimens shall be tested at 28 days for acceptance and one shall be tested at 7 days for information. The acceptance test results shall be the average of the strengths of the two specimens tested at 28 days. If one specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result. Should both specimens in a test show any of the above defects, the entire test shall be discarded. When high early strength concrete is used, the specimens shall be tested at the ages indicated in the contract documents.
4. Make at least one strength test for each 100 cu yd, or fraction thereof, of each mixture design of concrete placed in any 1 day. When the total quantity of concrete with a given mixture design is less than 50 cu yd, the strength tests may be waived by the Architect if, in his judgment, adequate evidence of satisfactory strength is provided, such as strength test results for the same kind of concrete supplied on the same day and under comparable conditions to other work or other projects.
5. When accelerated testing of concrete is permitted as an alternative to standard testing, mold and cure two specimens from each sample in accordance with ASTM C 684, following the procedure specified by the Architect. Make at least one accelerated strength test for each 100 CU. YD. of concrete placed in any one day, of each mixture design of concrete placed in any one day, and one standard 28 day compressive strength test for at least every other accelerated strength test. Use these test results to maintain and update the correlation between accelerated and standard 28 day compressive strength tests.

6. Submit correlation data for the standard 28 day compressive strength test based on a minimum of 12 to 15 sets of test data covering the range of 2500 to 6000 psi concrete made with the same materials. Submit the correlation data for review.

E) Determine slump of the concrete sample for each strength test and whenever consistency of concrete appears to vary, using ASTM C 143.

F) Determine air content of normal weight concrete sample for each strength test in accordance with either ASTM C 231, ASTM C 173, or ASTM C 138.

G) Determine air content and unit weight of lightweight concrete sample for each strength test in accordance with ASTM C 173 and ASTM C 567.

H) Determine temperature of concrete sample for each strength test.

4 - ADDITIONAL SERVICES WHEN REQUIRED

The following services shall be performed by the designated agency:

A) Inspect concrete batching, mixing, and delivery/ operations to the extent deemed necessary by the Architect.

B) Sample concrete at point of placement and perform required tests.

C) Review the manufacturer's report for each shipment of cement, reinforcing steel and prestressing tendons and/ or conduct laboratory tests or spot checks of the materials as received for compliance with specifications.

D) Other testing or inspection services as required

5 - OTHER SERVICES AS NEEDED

The following services shall be performed by the designated agency when necessary:

A) Additional testing and inspection required because of changes in materials or proportions requested by the Contractor.

B) Additional testing of materials or concrete occasioned by their failure by test or inspection to meet specification requirements.

6 - DUTIES AND AUTHORITIES OF DESIGNATED TESTING AGENCY

A) Representatives of the agency shall inspect, sample and test the materials and the production of concrete as required by the Architect. When it appears that any material furnished of work performed by the Contractor fails to fulfill specification requirements, the testing agency shall report such deficiency to the architect and the Contractor.

B) The agency shall report all test and inspection results to the Architect, Contractor, and concrete supplier immediately after the work is performed. All test reports shall include the exact location in the work at which the batch represented by a test was deposited. Reports of strength tests shall include detailed information on storage and curing of specimens prior to testing.

C) The testing agency and its representatives are not authorized to revoke, alter, relax, enlarge or release any requirement of the contract documents, not to approve or accept any portion of the work.

7 - RESPONSIBILITIES AND DUTIES OF CONTRACTOR

A) The Contractor shall provide the necessary testing services for the following:
   1. Qualification of proposed materials and the establishment of mixture designs.
   2. Other testing services needed or required by the Contractor.

B) The use of testing services shall in no way relieve the Contractor of the responsibility to furnish materials and construction in full compliance with the contract documents.

C) The Contractor shall submit to the Architect the concrete materials and the mixture designs proposed for use with a written request for acceptance. This submittal shall include the results of all testing performed to qualify the materials and to establish the mixture designs proposed for use with a written request for acceptance. This submittal shall include the results of all testing performed to qualify the materials and to establish the mixture designs. No concrete shall be placed in the work until the Contractor has received such acceptance in writing.

D) To facilitate testing and inspection, the Contractor shall:
   1. Furnish any necessary labor to assist the designated testing agency in obtaining and handling samples at the project or other sources of materials.
   2. Advise the designated testing agency sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.
   3. Provide and maintain for the sole use of the testing agency adequate facilities for safe storage and proper curing of concrete test specimens on the project site for the first 24 hr as required by ASTM C 31.
   4. Submit copies of mill test reports for shipments of cements, reinforcing steel and prestressing tendons to the Architect.

(server-admin-especificaciones-03-116)

SECTION 03117: EVALUATION AND ACCEPTANCE OF CONCRETE STRENGTH

1 - Evaluation of test results:

A) Test results for standard molded and standard cured test cylinders shall be evaluated separately for each specified concrete mixture design. Such evaluation shall be valid only if tests have been conducted in accordance with procedures specified in Section 03116.

B) For evaluation, each specified mixture design shall be represented by at least five tests.

2 - ACCEPTANCE OF CONCRETE

The strength level of the concrete will be considered satisfactory so long as the averages of all sets of three consecutive strength results equal or exceed the specified strength f'c and no individual strength f'c by more than 500 psi. These criteria apply also when accelerated strength testing is specified, unless another basis for acceptance is specified in the contract documents.

3 - TESTING OF CONCRETE IN PLACE

A) Testing by impact hammer, sonoscope, or other non-destructive device may be permitted by the Architect to determine relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection.

B) Core tests:

1. Where required, cores at least 2 in. in diameter shall be obtained and tested in accordance with ASTM C 42. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 F, relative humidity less than 60 percent) for 7 days before testing and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42.

2. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by the Architect to least impair the strength of the structure. If, before testing, one or more of the cores shows evidence or having been damaged subsequent to or during removal from the structure, it shall be replaced with a new core.
3. Concrete in the area represented by a core test will be considered adequate if the average strength of the cores is equal to at least 85 percent of specified strength f'c and if no single core is less than 75 percent of the specified strength f'c.
4. Core holes shall be filled with low slump concrete of mortar. See Section 03109, "Repair of Surface Defects".

(server-admin-especificaciones-03-117)

SECTION 03118: ACCEPTANCE OF CONCRETE STRUCTURE

1 - GENERAL

A) Completed concrete work which meets all applicable requirements will be accepted without qualification.

B) Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.

C) Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these specifications or in the contract documents. In this event, modifications may be required to assure that remaining work complies with the requirements.

2 - DIMENSIONAL TOLERANCES

A) Formed surfaces resulting in concrete outlines smaller than permitted by the tolerances of Section 03104, Article 3 shall be considered potentially deficient in strength and subject to the provisions of Article 4 of this section.

B) Formed surfaces resulting in concrete outlines larger than permitted by the tolerances of Section 03104, Article 3 may be rejected and the excess material shall be subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance.

C) Concrete members cast in the wrong location will be rejected.

D) Inaccurately formed concrete surfaces exceeding the limits of Section 03104-, Article 3 or of Section 03113, Article 3, and which are exposed to view, will be rejected and shall be repaired or removed and replaced as required by the Architect.

E) Finished slabs exceeding the tolerances of Section 03111, Article 9 may be repaired provided that strength or appearance is not adversely affected. High spots may be removed with a terrazo grinder, low spots filled with a patching compound, or other remedial measures approved by the Architect.

3 - APPEARANCE

A) Architectural concrete with surface defects exceeding the limitations of Section 03113, Article 3-A shall be removed and replaced.

B) Other concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired only by acceptable methods.

4 - STRENGTH OF STRUCTURE

A) The strength of the structure in place will be considered potentially deficient if it fails to comply with any requirements which control the strength of the structure, including but not necessarily limited to the following conditions.

1. Low concrete strength as designated in Section 03117.
2. Reinforcing steel size, quantity, strength, position, or arrangement at variance with the requirements of Section 03105, "Reinforcement", or the contract documents.
3. Concrete which differs from the required dimensions or location in such a manner as to reduce the strength.
4. Curing less than that specified.
5. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
6. Mechanical injury as defined in Section 03112, Article 4, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
7. Poor workmanship likely to result in deficient strength.

B) Structural analysis and/or additional testing may be required when the strength of the structure is considered potentially deficient.

C) Core tests in accordance with Section 03117, Article 3-B may be required when the strength of the concrete in place is considered potentially deficient.

D) If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required and their results evaluated in accordance with ACI 318.

E) Concrete work judged inadequate by structural analysis or by results of a load test shall be reinforced with additional construction if so directed by the Architect or shall be replaced, at the Contractor's expense.

F) The Contractor shall pay all costs incurred in providing the additional testing and/or analysis required by this Section.

(server-admin-especificaciones-03-118)

SECTION 05100: STRUCTURAL STEEL

1. SCOPE

   A. Furnish, fabricate, mark for erections, ship to the site and erect all structural steel shown on the Drawings, specified herein, and needed for a complete and proper completion of the work.

2. QUALITY ASSURANCE

   A. Use adequate number of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

   B. Qualify welding processes and welding operators in accordance with the American Welding Society (AWS) "Standards for Qualification of Welding Procedures and Welders for Piping and Tubing".

   C. Fabrication and erections shall comply with all requirements of the latest editions of the AISC (American Institute of Steel Construction) Manual of Steel Construction and AWS D1.1 Structural Welding Code-Steel and the requirements of this sections.

3. SUBMITTALS

   A. Submit all product data within 45 calendar days after the Contractor has received the Owner's Notice to Proceed.

   B. Product Data:
      1. Submit procedures' or manufacturers' specifications and installation recommendations for the following products, including laboratory test reports and other data required to prove compliance with the specified requirements.
         a) Structural steel, including certified copies of mill test reports covering chemical and physical properties;
         b) High strength bolts, including nuts and washers;
         c) Unfinished bolts and nuts;
         d) Structural steel primer paint.

2. Shop Drawings including complete details and schedules for fabrication and shop assembly of members.
   a) Include details of cuts, connections, camber, holes, and other pertinent data;
   b) Indicate welds by AWS symbols, and show size, type, and length of weld;
   c) Provide setting drawings, templates and directions for installing anchor bolts and other required anchors;
   d) Identify details by reference to sheet and detail number of the Drawings.

4. PRODUCT HANDLING

A. Delivery and Storage:
   1. Deliver materials to the job site properly marked to identify the location for which they are intended.
   2. Use markings corresponding to markings shown on the approved Shop Drawings.
   3. Store in manner to maintain identification and to prevent damage.

5. PRODUCTS

A. Materials:
   1. Rolled steel plates and bars:Comply with ASTM A36.
   2. Steel pipe: Comply with ASTM A53, Type E or S, Grade B and, where applicable, API-5L, Grade B.
   3. Steel tube: Comply with ASTM A501.
   4. Anchor bolts: Comply with ASTM A307, non-headed type with heavy hexagonal nuts unless otherwise indicated.
   5. Unfinished threaded fasteners:
      a) Comply with ASTM A307, Grade A, regular low carbon steel bolts and nuts.
      b) Provide either hexagonal or square heads and nuts; except use only hexagonal units for exposed connections.
   6. High strength threaded fasteners: Provide heavy hexagonal structural bolts, heavy hexagonal nuts, and hardened washers, all from quenched and tempered medium carbon steel complying with ASTM A325, unless otherwise specified.
   7. Primer: Use "10-99 Tnemec Primer", "Rustoleum No. 5769 Primer", or equal approved in advance by the Architect.
   8. Electrodes for welding: The welded metal used shall be rated for Charp V-Notch (CVN) values of 20 ft.-lbs. at a temperature 30° F colder than the last,

and that test temperature shall not be above 0°F. This may be determined based on the electrode classification system, or by performing CVN test in accordance with AWS A 5.x filler metal specifications. Shield metal ARC welding (SMAW) electrodes shall be E7018.

6. FABRICATION

A. Shop Fabrication and Assembly:
   1. Fabricate items of structural steel in accordance with AISC specifications, and as indicated on the approved Shop Drawings.
   2. Properly mark and match-mark materials for field assembly and for identification as to location for which intended.
   3. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.
   4. Where finishing is required, complete the assembly, including welding of units, before start of finishing operations.
   5. Provide finish surfaces of members exposed in the final structure free from markings, burrs, and other defects.

B. Connections:
   1. Provide bolts and washers of types and sizes requiered for completion of field erection.
   2. High strength bolted construction:
      a) Install high strength threaded fasteners in accordance with AISC "Specifications for Structural Joints Using ASTM A325 or A490 Bolts."
      b) Use A325N bolts unless noted otherwise.
   3. Welded construction: Comply with AWS Code for procedures, appearance, and quality of welds, and methods used in correcting welded work.
   4. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.

C. Holes for Other Work:
   1. Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on the approved Shop Drawings.
   2. Provide threaded nuts welded to framing, and other specialty items as shown, to receive other work.
   3. Cut, drill, or punch holes perpendicular to metal surfaces.

4. Do not flame cut holes or enlarge holes by burning.
5. Drill holes in bearing plates.

5. SHOP PAINTING

A. General:
1. Shop paint structural steel work, except those members or portions of members to be embedded in concrete or mortar.
2. Paint embedded steel which is partially exposed on the exposed portions, and the initial 2" of embedded areas only.
3. Do not paint surfaces which are to be welded or high-strength bolted with friction type connections.
4. Apply two coats of paint to surfaces which are inaccessible after assembly or erection. Change color of the second coat to distinguish it from the first.

B. Surface Preparation:
1. After inspection and before shipping, clean steelwork to be painted.
2. Remove loose rust, loose mill scale, and spatter, slag, and flux deposits.
3. Clean steel in accordance with Steel Structures Painting Council SP-3, "Power Tool Cleaning."

C. Painting:
1. Immediately after surface preparation, apply structural steel primer paint in accordance with the manufacturer's recommendations and at a rate to provide a uniform dry film thickness.
2. Use painting methods which will result in full coverage of joints, corners, edges, and exposed surfaces.

6. SURFACE CONDITIONS

A. Examine the area and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

7. ERECTION

A. Comply with AISC specifications and "Code of Standard Practice", except as may be modified herein.

B. Anchor Bolts:
   1. Provide anchor bolts and other connector required for securing structural steel to foundations and other inplace work.
   2. Provide templates and other devices necessary for presetting bolts and anchors to accurate locations.

C. Bases and bearing plates: Shop weld to columns and members attached to concrete.

D. Splicing:
   1. Splice members only where indicated unless, with the Architect's approval, splices not indicated would result in lower costs due to reduced shipping expense.
   2. For splices not indicated, submit structural calculations prepared and signed by a structural engineer licensed to practice where the fabricator is located.

E. Gas Cutting:
   1. Do not use gas cutting torches for correcting fabricating errors in the structural framing.
   2. Cutting will be permitted only in secondary members as acceptable to the Architect/Engineer.
   3. When gas cutting is permitted, finish the gas cut section to a sheared appearance acceptable to the Architect/Engineer.

F. Surveys
   1. Establish permanent benchmarks necessary for accurate erection of structural steel.
   2. Check elevations of concrete surfaces, and locations of anchor bolts and similar items, before erection proceeds.

G. Temporary Shoring and Bracing:
   1. Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads.
   2. Provide temporary guy lines to achieve proper alignments of the structure as erection proceeds.
   3. Remove temporary connections and members when permanent members are in place and the final connections have been made.

H. Setting Bases and Bearing Plates:
   1. Clean concrete bearing surfaces free from bond-reducing materials, and then roughen to improve bond to the surface.

2. Clean the bottom surface of base and bearing plates.
3. Set loose and attach base plates and bearing plates for structural members in wedges or other adjusting devices.
4. Tighten anchor bolts after the supported members have been positioned and plumbed.
5. Do not remove wedges or shims but, if protruding, cut off flush with the edge of the base or bearing plate prior to packing with grout.
6. Pack grout solidly between bearing surfaces and bases or plates to assure that no voids remain.
7. Finish exposed surfaces, protect installed materials, and allow to cure in strict compliance with the manufacturers' recommendations as approved by the Architect/Engineer.

I. Field Assembly:
1. Set structural frames accurately to the lines and elevations indicated.
2. Align and adjust members forming part of a complete frame or structure before fastening permanently.
3. Clean the bearing surface and other surfaces which will be in permanent contact, before assembly.
4. Adjust as required to compensate for discrepancies in elevation and alignment.
5. Level and plumb individual members of the structure within specified AISC tolerances.
6. Establish required leveling and plumbing measurements on the mean operating temperature of the structure, making allowances for the difference between temperature at which the structure will be when completed and in service.
7. Comply with AISC specifications for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to welds.

8. TESTING AND INSPECTING

A. Testing:
1. The Owner's selected testing laboratory will pick up specimens and make required tests.
2. Cost of procuring test specimens at locations more than 50 miles from the job site will be paid by the Owner and backcharged to the Contractor.
3. Costs of tests of identified stock will be paid by the Owner; except that if a test fails to comply with the specified requirements, the cost of testing will be paid by the Owner and backcharged to the Contractor.

B. Test Specimens:
   1. Test specimens shall be furnished by the steel fabricator, and shall be taken under the direction of the Owner's selected testing laboratory.
   2. Each specimen shall be machined by the Owner's selected testing laboratory to dimensions required by ASTM A370.
   3. Cost of procuring, making, and machining test specimens shall be considered test costs as defined above.

C. Identification and Tests:
   1. If structural steel can be identified by heat or melt numbers, and if accompained by mill analysis and test reports, not less than one tension and one bend test will be made for each ten tons or fractional part thereof.
   2. If structural steel cannot be identified, or its source is questionable, not less than one tension test and one bend test will be made for each five tons or fractional part thereof.
   3. If steel pipe can be identified by heat or melt numbers, or manufacturer's name, not less than one tension test and one bend test will be made for each ten tons or fractional part thereof.
   4. Additional tests may be required when deemed necessary by the Architect/Engineer.

D. Inspecting:
   1. A complete four sided inspection of steel will be made when required by the Architect/Engineer.
   2. Cost of inspecting will be paid by the Owner subject to the same provisions made above for tests.
   3. If, after fabrication and inspection, the work of this Section is found to be defective and to require reinspection, cost of such reinspection will be paid by the Owner and backcharged to the Contractor.
   4. Provide labor, equipment, and facilities needed to move and handle the materials to be inspected.

E. Welding Inspection:
   1. Unless otherwise specified, perform welding under observation of a qualified inspector from a testing laboratory approved by the Architect/Engineer.
   2. Inspect every layer of weld for quality, penetration, and conformity with design requirements.

3. Require the welding inspector to submit a signed report to the Architect, verifying that:
   a) The welding is adequate and was performed in conformity with the specified requirements; and
   b) Adequate methods have been used to determine the quality of the welding.
4. The welding inspector may use gamma ray, magnaflux, trepanning, or any other aid to visual inspection considered necessary to assure adequacy of welding, or may use ultrasonic testing performed in accordance with pertinent requirements of governmental agencies having jurisdiction.
5. Cost of welding inspection will be paid by the Owner.

F. Access:
1. Provide access for the testing agencies and inspectors to places where structural steel work is being fabricated or produced, so that required testing and inspecting may be accomplished.

G. Erection Inspecting:
1. The Owner's testing and inspecting agency will inspect high strength bolted connections, will visually inspect field welded connections, will perform such additional tests and inspections of field work as are required by the Architect/ Engineer, and will prepare test reports for the Architect's review.
2. The testing agency will conduct and interpret the tests, and will state in each report whether the inspected work complies with the requirements, specifically stating all deviations therefrom.

H. Corrections:
1. Correct deficiencies in structural steel work which inspections and test reports indicate to be not in compliance with the specified requirements.
2. Perform additional tests required to reconfirm noncompliance of the original work and to show compliance of corrected work, all at no additional cost to the Owner.

9. FIELD PAINTING

A. General:
1. Prepare surfaces in a manner appropriate to the condition, and as approved by the Architect/ Engineer.

2. Clean spots and surfaces where primer coats have been removed, damaged, or burned off, and clean field bolts and other field connections not concealed in the finished work.
3. Remove dirt, oil, and grease.
4. Apply a spot coat of the approved primer.
5. Do not apply paint to wet, damp, oily or improperly prepared surfaces.

B. Notify the Architect when the work of this Section is ready to receive field painting.
1. Secure inspection and approval by the Architect prior to field painting.
2. Using spray or brush, as recommended by the manufacturer of the approved paint material, fill all joints and corners and cover the surfaces with a smooth unbroken film of at least 1.5 dry mils thickness.

SECTION 05300: METAL DECK

1. SCOPE

   A) Work included: Provide metal deck where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

2. QUALITY ASSURANCE

   A) Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

   B) When the materials of this Section are used as part of an assembly indicated on the Drawings in which fire-resistive construction ratings are required, demonstrate approval by Underwriters' Laboratories, Inc., and the governmental agencies having jurisdiction.

3. SUBMITTALS

   A) Product Data: Within 35 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
      1. Materials list of items proposed to be provided under this Section;
      2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
      3. Shop Drawings showing layout of decking, with details of materials, gages, accessories, openings, finishes, welds, and other pertinent conditions;
      4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.

4. METAL DECK UNITS

   A) Design the units in accordance with AISC "Specification for Design of Light Gage Cold-Formed Steel Structural Members," with appropriate steel fiber stress limitations and appropriate maximum live load deflection limitations.

   B) Provide pattern as shown on the Drawings, galvanized in accordance with ASTM A446, grade A, and ASTM A525, designation G60.

5. ACCESSORIES

A) Provide accessories specifically designed to be used with the metal deck units supplied to the Work, and as normal to the uses shown on the Drawings.

B) Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

6. SURFACE CONDITIONS

A) Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected..

7. INSTALLATION

A) Prior to start of installations, verify that beams are in proper alignment and that surfaces are clean for welding.

B) Place each unit on the supporting steel framework, and adjust to final position prior to permanent welding. Align each unit and fasten into final location in accordance with the manufacturer's recommended installation procedures as approved by the Architect.

C) Install accessory items in accordance with the manufacturer's recommended installation procedures as approved by the Architect.

8. TOUCHUP

A) Upon completion of installation, and as a condition of its acceptance, visually inspect each item installed under this Section and locate surfaces where finish was damaged.
   1. Touchup galvanized surfaces with zinc-rich primer or other galvanized repair paint approved for the purpose by the Architect.
   2. Touchup other damaged surfaces as required to return the surfaces to condition commensurate with the services required.

SECTION 05500: METAL FABRICATIONS

1. SCOPE

A) Work included: Provide the Railings Types A-1, A-2 A-3, A-4 and B, the Handrails I, II and III and any other miscellaneous metals shown on the Drawings, as specified herein, and as need for a complete and proper installation.

2. QUALITY ASSURANCE

A) Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B) Perform shop and/or field welding required in connection with the work of this Section in strict accordance with pertinent recommendations of the American Welding Society.

3. SUBMITTALS

A) Product data: Within 90 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
   1. Materials list of items proposed to be provide under this Section;
   2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
   3. Shop Drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades;
   4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.

4. DESIGN OF RAILINGS

A) Railing system shall withstand the loads as required by the P.R. Building Code. A uniform load of 50 pound per lineal foot must be applied horizontally at the top rail.

5. DELIVERY, STORAGE AND HANDLING

A) Deliver materials to the job site in good condition and properly protected against damage to finished surface.

B) Storage on site:
   1. Store material in a location and in a manner to avoid damage. Stacking shall be done in a way which will prevent bending.
   2. Store material in a clean, dry location away from uncured concrete and masonry. Cover with waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.

C) Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of material.

6. PRODUCTS

A) Railing Types A-1, A-2, A-3 and A-4 and Handrail Type I:
   1. Railing shall be shop fabricated with the materials specified in this Article of the Specification and to the dimensions shown on the drawings.
   2. Newel Post shall be casted with aluminum alloy No. 356. Shall consist of three castings: the base, housing and top cap. Design and dimensions as shown on the drawings. Castings shall be held together with two 9.525 mm steel zinc

plated tie rods and nuts as per ASTM A-153. Top cap shall be held in place with three socket set screws # 10-24 NC of stainless steel. Post will be anchored to the concrete slab with five HILTI HVA Adhesive Anchor composed of 10 mm φ x 400 mm long anchor bolts, and 10 mm φ x 90 mm HEA Adhesive Capsules. Anchor bolts shall be A 307 with nut and washer hot dip galvanized meeting ASTM A-153.

3. Top Rail shall be fabricated from aluminum (alloy 6063-T5) pipe, Schedule 40, of the nominal sizes and shapes shown on the drawings.
4. Support section and bottom tube shall be fabricated from aluminum (6063-T5) rods with the nominal sizes and shapes shown on the drawings
5. Balauster shall be fabricated from aluminum (6063-T5) extruded rectangular tube of the sizes and shapes shown on the drawings
6. Band shall be fabricated from aluminum (6063-T5) extruded rectangular bars of the sizes and shapes shown on the drawings. Welded to form specified shapes.
7. All joints between sections shall be fully welded all around. The welding process shall be gas metal ARC Welding with shielding gas (Heliarc by Union Carbide in Argon Atmosphere-High Frequency). Follow the requiremens of the AWS "Structural Welding Code-Aluminum".
8. Fabricate with accurate angles and surfaces which are true to the required lines, and levels, grinding exposed welds smooth and flush, and forming exposed connections with hairline joints.
9. Aluminum section shall be mill finished.

After fabrication properly clean metal surfaces as required for the applied finish and for the proposed use.

10. Finish: Factory prime one coat of GLID GUARD EPOXY Chromate Metal Primer No. 5251/5252, and field painted one coat GLID GUARD Universal Fast Dry Metal Primer No. 5210 and one coat GLID GUARD Silicone Alkyd Enamel No. 5539. Above systems by The Glidden Paint Company. Color to be selected by Architect.
11. Commnowealth of P.R. has reserved its copyright on the design of the above refered Railing Type B. This design can not be used in any other project within P.R. and elsewhere, unless written authorization is obtained from the Commonwealth of P.R.

B. Railing Type B and Handrail Type II:
1. Railing and Components shall be as manufactured by Julius Blum & Co. Inc. of Carlstadt, New Jersy (201) 438-4600 or an approved equal.
2. Sections shall be fabricated from aluminum extruded sections, alloy 6063. Finish shall be clear anodized finish meeting AA - M10 - C22 - A 31.
3. Fasteners shall be stainless steel or aluminum as recommended by the manufacturer. All fasterners shall be concealed as much as posible.
4. Form rail-to-end post connections and all changes in rail direction by radius elbows.
5. Cut material square and remove burrs from all exposed edges, with no chamfer.
6. Make exposed joints butt tight, flush and hairline.
7. Close exposed ends of handrail, by use of appropriate end cap.

8. For posts set in concrete, furnish matching sleeves or inserts not less than 5 inches long.
9. Verity dimmensions on site prior to shop fabrication.

C. Handrail Type III:
1. Handrail shall be fabricated from steel pipes meeting ASTM A-501, Standard Grade, and hot dip galvanized as per ASTM A-123, steel plates, shapes and bars shall be ASTM A-36 and hot dip galvanized. Bolts and fastenners shall be A-307 and hot dip galvanized including nuts and washer meeting ASTM A-153.
2. Except as otherwise shown on the Drawings or the approved Shop Drawings, use materials of size, thickness, and type required to produce reasonable strength and durability in the work of this Section.
3. Fabricate with accurate angles and surfaces which are true to the required lines and levels, grinding exposed welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible.
4. Prior to shop painting or priming, properly clean metal surfaces as required for the applied finish and for the proposed use of the item.

5. Finish: Factory prime one coat of GLID GUARD EPOXY Chromate Metal Primer No. 5251/5252, and field painted one coat GLID GUARD Universal Fast Dry Metal Primer No. 5210 and one coat GLID GUARD Silicone Alkyd Enamel No. 5539. Above systems by The Glidden Paint Company. Color to be selected by Architect.
6. On surfaces inaccessible after assembly or erection, apply two coats of the

specified primer. Change color of second coat to distinguish it from the first.

7. COORDINATION

A) Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

8. DISSIMILAR METALS

A) When aluminum components come into contact with dissimilar metals, surfaces shall be kept from direct contact by painting the dissimilar metal with a heavy coat of a proper primer.

B) When aluminum components come into contact with cement or lime mortar, exposed aluminum surfaces shall be painted with heavy bodied bituminous paint.

9. SURFACE CONDITIONS

A) Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

10. INSTALLATION

A) General:
   1. Set work accurately into position, plumb, level true, and free from rack.
   2. Anchor firmly into position.
   3. Where field welding is required, comply with AWS recommended procedures of manual-shielded metal-arc welding for apearance and quality of weld and for methods to be used in correcting welding work.
   4. Grind exposed welds smooth, and touchup shop primer coats.

5. Do not cut, weld, or abrade surfaces which have been hot-dip galvanized after fabrication and which are intended for bolted or screwed field connections.

B) Immediately after erection, clean the field welds, bolted connections, and abraded areas of shop priming. Paint the surfaces as indicated on Article 6 of this Section of the Specifications.

SECTION 05700: MISCELLANEOUS METAL WORK

1. SCOPE

   A) Includes all miscellaneous metal items shown on drawings and not specifically called for under other sections of the specifications.

   B) In general, such items include, but are not necessarily limited to, the following:
      1. Roof ladders
      2. Stair nosings
      3. Metal gates and grilles
      4. Steel pipe railings

   C) In general, miscellaneous metal items are shown on drawings by manufacturer and model number. In such cases they shall be of materials and finishes and shall have such anchorage or appurtenances as are standard with the manufacturer for the model number cited.

   D) Note that stair nosings shall be furnished six inches shorter than the total width of the stair.

2. SHOP DRAWINGS AND SAMPLES

   A) Submit shop drawings and/or manufacturer's literature showing details of construction and installation.

   B) When requested, submit samples or sample sections of any or all items.

   C) Do not install without prior written approval of items.

3. GENERAL

   A) Workmanship:
      1. All work shall be in accordance with the best practice of the trade, shop fabricated in so far as possible.
      2. All finished members shall be true to dies, with accurate, sharp arrises, free from warps, bends or twists.
      3. Joints, corners, copes and miters shall be accurately machined, framed together at contact points and rigidly fastened. Surfaces of joints and connections shall match finish or adjacent.

3. GENERAL (CONT.)

4. Removable members, such as glass stops, shall be properly machined and fitted and secured with approved tap screws. All other fastenings shall be concealed.
5. Set and anchor firmly to concrete or masonry as detailed on drawings or as approved.
6. All metals shall be free from defects impairing strength, durability, or appearance, and shall be of the best commercial quality for the purpose specified.
7. In general, aluminum extrusions shall be of 6063-T5 alloy, commercial tolerances and finish.
8. All work called for to be galvanized shall be hotdipped galvanized after fabrication. Zinc coating by weight shall be not less than 1.2 ounces per square foot and shall withstand not less than six one-minute immersions by the Preece Test.
9. Fabrication and delivery shall be scheduled so as not to delay the orderly progress of the work.
10. Joints shall be strong and rigid; welded joints shall be dressed flush and smooth where exposed in the finished work. Joints exposed to the weather shall be formed so as to exclude water. Exposed joints shall be close fitting and shall be made where least conspicuous; jointing in the face of flat surfaces and in the run of moldings is generally prohibited.
11. Accessories and connections shall in general be the same in material and finish as the work to which they are attached; those in cast iron, however, shall be steel, of finish to match the casting. Bolts, screws, etc., exposed to view shall be cut off flush with nuts or adjacent metal. Threaded connections shall be made up tightly so that the threads will be entirely concealed by the fittings. Exposed bolt or screw heads shall be avoided where possible; where visible, countersunk flat heads shall be provided.

B) Protection:
1. Insulation between non-ferrous metal and disimilar metals shall be a heavy coat of zinc-chromate primer, or other as detailed.

3. GENERAL (CONT.)

2. Insulation between aluminum in contact with concrete or mortar or with other metals, except stainless steel, shall be a heavy paint coat of alkali resistant bituminous paint.
3. All exposed finish surfaces shall have a factory applied finish coat to protect against stain, discoloration or injuries. Do not remove finish coat until plastering, floor finishing, painting, etc., are completed.

4. MISCELLANEOUS FERROUS METAL ITEMS

A) Miscellaneous ferrous metal items such as angles, strips, clips, etc., shall be as detailed on drawings, galvanized steel unless other material is noted on drawings.

B) Install and erect as detailed on drawings or approved shop and erection drawings.

C) All exposed surfaces of ferrous metal items shall be field painted as specified under Division 9.

5. MISCELLANEOUS NON FERROUS METAL ITEMS

A) Miscellaneous non ferrous metal items shall be materials, types, etc., detailed on drawings.

B) Install and erect as detailed on drawings or approved shop and erection drawings.

END OF SECTION

SECTION 06100: CARPENTRY AND MILLWORK

1. SCOPE

A) Includes all carpentry and millwork (except work specified under other sections) shown on drawings and specified herein, including, but not necessarily limited to, the following major items:

1. Rough Items
   a. Temporary protection
   b. Temporary enclosures
   c. Rough wood bucks, framing, blocking, sleepers, etc.
   d. Rough hardware as required
   e. Backpainting

2. Finish Carpentry and Cabinet Work
   a. Laminated plastic covered items
   b. Wood windows
   c. Plywood items
   d. Frames and sash
   e. All other miscellaneous finish items as shown on drawings.

B) The above list is intended to provide a general concept of the carpentry and millwork required. It is not necessarily complete or exact and the Contractor shall in all instance provide all materials for and shall execute all carpentry and millwork shown on the drawings or reasonably required to finish the project at no additional cost to the Owner.

2. QUALITY ASSURANCE

A) Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B) Codes and Standards:

1. In addition to complying with pertinent codes and regulations of governmental agencies having juris-

diction, unless otherwise specifically directed or permitted by the Architect comply with:

a. "Product Use Manual" of the Wester Wood products Association for selection and use of products included in that manual;
b. "Plywood Specification and Grade Guide" of the American Plywood Association;
c. "Standard Specifications for Grades of California Redwood Lumber" of the Redwood Inspectio Bureau for Redwood, when used.

3. PRODUCT HANDLING

A) Protection:
1. Deliver the materials to the job site and store, in a safe area, out of the way of traffic, and shored up off the ground surface.
2. Identify framing lumber as to grades, and store each grade separately from other grades.
3. Protect metals with adequate waterproof outer wrapping.
4. Use extreme care in off loading of lumber to prevent damage, splitting, and breaking of materials.

4. SHOP DRAWINGS AND SAMPLES

A) Submit carpentry and millwork shop and installation drawings showing materials, joinery, details, anchoring, hardware, and relation to adjacent work. Full size details and profiles will be required for windows. When so requested full size details and profiles of other items will also have to be provided.

B) Submit samples of any or all materials to the Architect.

C) Do not start fabrication or installation until shop drawings and samples are approved by the Architect.

5. MATERIALS (WOOD)

A) General Requirements:

1. All lumber, veneer, plywood and miscellaneous plywood shall be of species and grade specified below,
2. Each piece of lumber or plywood shall bear the official grade mark of the manufacturer's association under which it is produced; or a certificate of inspection satisfactory to the Architect.
3. Properly stack and store all lumber and wood to protect from dampness and injury.

B) Species Requirements:
1. Brazilian Walnut (Imbuya) - Selected Stock
2. Douglas Fir and/or Southern Yellow Pine-(Solid Stock)- Utility Grade for Douglas Fir, No.2 Common for Souther Yellow Pine. Rough and concealed blocking, framing, nailers, sleepers, etc.
3. Plywood-wherever plywood is indicated on drawings and not indicated by species or as Lauan plywood it shall be Douglas Fir Plywood Association as follows:
Plywood exposed one side EXT-A-C
Plywood to receive plastic laminate EXT-B-C

6. MATERIALS (OTHER THAN WOOD)

A) Fastening and Anchoring:
1. Screws and bolts-Federal Spec. FF-S-llla, non ferrous stainless steel or aluminum.
-Screws and bolts fastening hardware to match finish of hardware; other exposed to be stainless steel; aluminum, bronze or other approved non-ferrous metal.
-Nails, bolts, buch anchors, clips, etc., to be stainless steel, unless otherwise shown.

B) Laminated Plastic - Formica, Micarta or Nevamar colors and patterns to be selected by the Architect.

C) Other miscellaneous items - best commercial quality available.

7. PRESERVATIVE TREATMENT

A) All lumber and millwork items; except Douglas Fir plywood items and all hardwood plywood and hardwood solid stock items, shall receive pressure preservative treatment in accordance with Federal Specification TT-W-571, with any of the specified treatments optional provided that treated surfaces shall be suitable for finishes specified.

B) Lumber sawed or cut after treatment to have the cut surfaces well brush-coated with same preservative used at the plant. Lumber to be accompanied by a certificate from a recognized lumber treatment company, certifying the amount of treatment and percentage of moisture after kiln drying.

C) All fir plywood items and miscellaneous shop fabricated items shall be treated in accordance with Federal Specifications TT-W-572. Treatment shall be 5 minute immersion wherever practicable, otherwise by thoroughly brush drenching. All surfaces cut, sawed or planed after treatment shall be thoroughly brush drenched with same solution as the treatment.

8. CARPENTRY, PROTECTION, ETC.

A) Temporary Protection:
   1. Protect ornamental work and other built-in work where exposed to possible damage by suitable temporary wood boxing or other approved covering.
   2. Provide temporary protection for stairs, ramps, bridges in the form of temporary wood handrail, and in the case of wood surfaces items, a temporary traffic surface of clean, smooth, wood.
   3. Maintain temporary protection in good repair until removal is approved.

B) Temporary Enclosure:
   1. Provide temporary wood doors and partitions and temporary covering for window openings where necessary to protect interior building from damage by weather.

C) Rough Bucks and Blocking:

1. Provide wood rough bucks, blocking, framing, nailing strips, wood furring, other similar rough carpentry where shown or required for proper fastening of finished frames and woodwork, sheet metal work, flashing, miscellaneous and ornamental metal work, similar items.
2. Blocking set in wet concrete to be dovetail shaped in section and have cut nails driven into edges as additional anchorage.
3. Other blocking and rough bucks applied to concrete to be fastened at no greater than two-foot intervals, with at least two fastenings per piece, by one of the following methods.

   Lag-screwing to wood blocking set in the wet concrete as specified.

   Anchor bolting.

   Bolting to approved concrete cast-in inserts.

   Expansion bolting with approved cinch-type anchors.

   Powder - driven stud bolts of sizes and types as approved.

4. Set nailing strips and furring plumb and true, shimmed out as necessary. Unless shown otherwise on the drawings, material shall be one inch by two inches nominal size or larger.

D) Rough Hardware:

1. Furnish all rough hardware and metal fastening as required for proper installation of carpentry and millwork.
2. Anchor bolts, expansion anchors, bolts, toggle-bolts, or lag screws to be of sizes shown on the drawings, in no case less than 5/16 inch.

9. MISCELLANEOUS WOOD SASH, FRAMES, AND WINDOWS

A) They shall be fabricated and erected in strict accordance with the details of the drawings or approved shop drawings. Wherever possible, members shall be milled from one continuous length. All joints shall be mortised and tenoned, or approved equal, and shall be reinforced with concealed bronze plates and angles where necessary for rigidity.

B) Unless otherwise noted on the drawings, all miscellaneous wood sash, frames, or windows shall be solid stock - Brazilian Walnut (Imbuya).

C) Screws and fastenings shall be brass or bronze.

D) Factory apply primer and paint as per painting schedule. Submit sample for Architect approval.

E) Secure template from finish hardware supplier and accurately install or make provisions for all, finish hardware at the factory.

10. MISCELLANEOUS COUNTER WORK

A) All counter work shall be executed in strict accordance with the details of the drawings or the details of approved shop drawings, the latter to take precedence.

B) In general, all joints shall be mortise or tenoned and glued, and reinforced with concealed bronze plates or angles where required for rigidity.

11. MISCELLANEOUS MILLWORK AND CARPENTRY ITEMS

A) All other miscellaneous millwork and carpentry items not specifically mentioned herein shall be fabricated and erected in strict accordance with the details of the drawings.

B) These items shall be constructed from the materials shown on drawings. When wood items are shown and no species is indicated, these items shall be Brazilian Walnut, unless otherwise directed.

12. LAMINATED PLASTIC ITEMS

A) All visual counter and cabinet surfaces shall be faced with laminated plastic.

13. SURFACE CONDITIONS

A) Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

14. WORKMANSHIP

A) Produce joints which are true, tight, and well nailed with all members assembled in accordance with the Drawings.

B) Jointing:
   1. Make joints to conceal shrinkage; miter exterior joints; cope interior joints; miter or scarf end-to-end joints.
   2. Install trim in pieces as long as possible, jointing only where solid support is obtained.

C) Fastening:
   1. Install items straight, true, level, plumb, and firmly anchored in place.
   2. Where blocking or backing is required, coordinate as necessary with other trades to ensure placement of required backing and blocking in a timely manner.
   3. Nail trim with finish nails of proper dimension to hold the member firmly in place without splitting the wood.
   4. Nail exterior trim with galvanized nails, making joints to exclude water and setting in waterproof glue or the sealant described in Section 07920 of these specifications.
   5. On exposed work, set nails for putty.
   6. Screw, do not drive, wood screws; except that screws may be started by driving and then screwed home.

15. INSTALLATION OF OTHER ITEMS

A) Install items in strict accordance with the drawings and the recommended methods of the manufacturer as approved by the Architect, anchoring firmly into position at the prescribed locations, straight, plumb, and level.

16. FINISHING

A) Sandpaper finished wood surfaces thoroughly as required to produce a uniformly smooth surface, always sanding in the director of the grain; except do not sand wood which is designed to be left rough.

B) No coarse grained sandpaper mark, hammer mark, or other imperfection will be accepted.

17. CLEANING UP

A) Keep the premises in a neat, safe, and orderly condition at all times during execution of this portion of the Work, free from accumulation of sawdust, cut-ends, and debris.

B) Sweeping:
   1. At the end of each working day, and more often if necessary, thoroughly sweep surfaces where refuse from this portion of the Work has settled.
   2. Remove the refuse to the area of the job site set aside for its storage.
   3. Upon completion of this portion of the Work, thoroughly broom clean all surfaces.

END OF SECTION

SECTION 07 22 00

ROOF INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Work shall include, but is not limited to, the following:
   1. Preparation of [existing] roof deck and all flashing substrates.
   2. Temporary Tear Self Adhered SBS Modified Membrane
   3. Insulation Coated Glass Facer
   4. Asphaltic Cover-board
   5. SBS Modified Bitumen Laminated Cover-board
   6. All related materials and labor required to complete specified roofing necessary to receive specified manufacturer's warranty.

1.02 RELATED SECTIONS

A. Division 010000 – General Requirements
B. Division 011000 – Summary of Work
C. Division 075216 – Styrene-Butadiene-Styrene (SBS) Modified Bitumen Membrane Roofing
D. Division 076200 – Sheet Metal Flashing and Trim

1.03 DEFINITIONS

A. ASTM D 1079-Definitions of Term Relating to Roofing and Waterproofing.
B. The National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual, Fifth Edition Glossary.

1.04 REFERENCES

A. AMERICAN SOCIETY OF CIVIL ENGINEERS - Reference Document ASCE 7, Minimum Design Loads for Buildings and Other Structures.
B. AMERICAN STANDARD OF TESTING METHODS (ASTM):
   1. ASTM C 1278 - Standard Specification for Fiber-Reinforced Gypsum Panel.
   2. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Insulation Board.
   3. ASTM D 41 - Standard Specification for Asphalt Primer Used in Roofing, Damp proofing, and Waterproofing.
C. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)::
   1. ANSI/SPRI FX-1, Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.
   2. ANSI/SPRI IA-1, Standard Field Test Procedure for Determining the Mechanical Uplift Resistance of Insulation Adhesives over Various Substrates.
   3. ANSI/FM 4474- American National Standard for Evaluating the Simulated Wind Resistance of Roof Assemblies Using Static Positive and/or

Negative Differential Pressures.

D. FACTORY MUTUAL (FM):
   1. FM 4450 - Approval Standard - Class I Insulated Steel Roof Decks.
   2. FM 4470 - Approval Standard - Class I Roof Covers.
E. INTERNATIONAL CODES COUNCIL (ICC):
   1. Latest Edition International Building Code (IBC).
F. NATIONAL ROOFING CONTRACTORS' ASSOCIATION (NRCA).
G. UNDERWRITERS LABORATORY (UL):
   1. UL 790 Standard Test Methods for Fire Tests of Roof Coverings.
   2. UL 1256 – Fire Test of Roof Deck Constructions.

1.05 ACTION SUBMITTALS

A. Product Data Sheets: Submit manufacturer's product data sheets, installation instructions and/or general requirements for each component.
B. Safety Data Sheets: Submit manufacturer's Safety Data Sheets (SDS) for each component.
C. Sample/Specimen Warranty from the manufacturer and contractor.
D. Shop Drawings: Provide roof plan and applicable roof system detail drawings.

1.06 INFORMATIONAL SUBMITTALS

A. Contractor Certification: Submit written certification from roofing system manufacturer certifying that the applicator is authorized by the manufacturer to install the specified materials and system.

1.07 CLOSEOUT SUBMITTALS

A. Warranty: Provide manufacturers and contractor's warranties upon substantial completion of the roofing system.

1.08 QUALITY ASSURANCE

A. MANUFACTURER QUALIFICATIONS:
   1. Manufacture shall have 20 years of experience manufacturing roofing materials.
   2. Trained Technical Field Representatives, employed by the manufacturer, independent of sales.
   3. Provide reports in a timely manner of all site visit reports.
   4. Provide specified warranty upon satisfactory project completion.
B. CONTRACTOR QUALIFICATIONS:
   1. Contractor shall be authorized by the manufacturer to install specified materials prior to the bidding period through satisfactory project completion.
   2. Applicators shall have completed projects of similar scope using same materials as specified herein.
   3. Contractor shall provide full time, on-site superintendent or foreman experienced with the specified roof system through satisfactory project completion.
   4. Applicators shall be skilled in the application methods for all materials.
   5. Contractor shall maintain a daily record, on-site, documenting material

installation and related project conditions.

6. Contractor shall maintain a copy of all submittal documents, on-site, available always for reference.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to each product data sheet or other published literature for specific requirements.

B. Deliver materials and store them in their unopened, original packaging, bearing the manufacturer's name, related standards, and any other specification or reference accepted as standard.

C. Protect and store materials in a dry, well-vented, and weatherproof location. Only materials to be used the same day shall be removed from this location.

D. When materials are to be stored outdoors, store away from standing water, stacked on raised pallets or dunnage, at least 4 in or more above ground level. Carefully cover storage with “breathable” tarpaulins to protect materials from precipitation and to prevent exposure to condensation.

E. Properly dispose of all product wrappers, pallets, cardboard tubes, scrap, waste, and debris. All damaged materials shall be removed from job site and replaced with new, suitable materials.

1.10 SITE CONDITIONS

A. SAFETY:

1. The contractor shall be responsible for complying with all project-related safety and environmental requirements.
2. Refer to NRCA CERTA recommendations, local codes and building owner’s requirements for hot work operations.
3. The contractor shall review project conditions and determine when and where conditions are appropriate to utilize the specified liquid-applied, or semi-solid roofing materials. When conditions are determined by the contractor to be unsafe or undesirable to proceed, measures shall be taken to prevent or eliminate the unsafe or undesirable exposures and conditions, or equivalent approved materials and methods shall be utilized to accommodate requirements and conditions.
4. The contractor shall review project conditions and determine when and where conditions are appropriate to utilize the specified hot asphalt-applied materials. When conditions are determined by the contractor to be unsafe or undesirable to proceed, measures shall be taken to prevent or eliminate the unsafe or undesirable exposures and conditions, or equivalent approved materials and methods shall be utilized to accommodate requirements and conditions.
5. The contractor shall refer to product Safety Data Sheets (SDS) for health, safety, and environment related hazards, and take all necessary measures and precautions to comply with exposure requirements.

B. ENVIRONMENTAL CONDITIONS:

1. Monitor substrate temperature and material temperature, as well as all environmental conditions such as ambient temperature, moisture, sun, cloud cover, wind, humidity, and shade. Ensure conditions are satisfactory to begin work and ensure conditions remain satisfactory during the installation of specified materials. Materials and methods shall

be adjusted as necessary to accommodate varying project conditions. Materials shall not be installed when conditions are unacceptable to achieve the specified results.

2. Precipitation and dew point: Monitor weather to ensure the project environment is dry before, and will remain dry, during the application of roofing materials. Ensure all roofing materials and substrates remain above the dew point temperature as required to prevent condensation and maintain dry conditions.

1.11 PERFORMANCE REQUIREMENTS

A. FIRE CLASSIFICATION:
   1. Roof construction performance testing shall be in accordance with UL 1256, FM 4450, or FM 4470 to meet the specified requirements for interior flame spread and fuel contribution.
      a. Roof construction meets requirements of UL 1256, or FM Class 1.

B. ROOF SLOPE:
   1. Finished roof slope shall be [¼]-inch per foot ([2] percent) minimum for roof drainage.
   2. Polyisocyanurate Insulation "R" Value: Shall be determined in accordance with ASTM C1289-11a.
   3. Thermal Resistance ‘R’ for the specified roof insulation system shall include the continuous insulation (ci) above the roof deck.
      a. Total Thermal Resistance R Value, continuous insulation (ci) above-deck: R-[00].

PART 2 PRODUCTS

2.01 MANUFACTURER

A. SINGLE SOURCE MANUFACTURER: All roofing materials shall be provided by a single supplier with 20 years or more manufacturing history in the US.
   1. Comply with the Manufacturer’s requirements as necessary to provide the specified warranty.

B. PRODUCT QUALITY ASSURANCE PROGRAM: Manufacturer shall be an ISO 9001 registered company.

C. ACCEPTABLE MANUFACTURER:
   1. SOPREMA, located at: 310 Quadral Dr.; Wadsworth, OH 44281; Tel: 800-356-3521; Tel: 330-334-0066; Website: www.soprema.us.
   2. Acceptable Alternate Manufacturers: Approved Equal by Architect

D. ROOFING SYSTEM BASIS OF DESIGN: SOPREMA

2.02 THERMAL INSULATION SYSTEM

A. RIGID INSULATION
   1. POLYISOCYANURATE INSULATION:
      a. SOPRA-ISO+: Closed cell polyisocyanurate foam core bonded on each side to a coated inorganic glass-reinforced facer.
         i Thickness: [0.0] in minimum board thickness. Total thickness to meet specified insulation system thermal resistance ‘R’ value.

ii Dimensions: [4 x 4 foot][4 x 8 foot] boards
iii Meets or exceeds ASTM C1289, Type II, Class 2, [Grade 2 (20 psi)].
iv Meets or exceeds ASTM D3273 for resistance to mold growth.

b. SOPREMA SOPRA-ISO+ Tapered Crickets: Closed cell polyisocyanurate foam core bonded on each side to a coated inorganic glass-reinforced facer, tapered to provide slope.
i Taper: [1/2 in] per foot. Insulation, crickets, and saddles provided with taper as required for positive roof slope.
ii Dimensions: 4 x 4 ft boards
iii Meets or exceeds ASTM C1289, Type II, Class 2, [Grade 2 (20 psi)].
iv Meets or exceeds ASTM D3273 for resistance to mold growth.

B. COVER-BOARD
1. ASPHALTIC ROOF BOARD
a. ¼ IN SOPREMA SOPRABOARD: Mineral fortified, asphaltic roof substrate board with glass fiber facers. For use as roof cover-board and for vertical flashing substrate. ASPHALTIC ROOF BOARD shall be manufactured by the membrane supplier.
i Thickness: 1/4 in
ii Dimensions: [4 x 4 ft] [4 x 8 ft] acceptable for mechanical attachment, insulation adhesive or asphalt application.
iii Water absorption: Less than 1 percent per ASTM D994.
iv Impact resistance: Included in FM Approvals per 4450/4470 for FM Severe Hail (SH) rating.
v Compressive strength, psi (kPa) measured at 50 percent compression, per ASTM C472:
a) ¼ in board: 1,320 (9,100)
vi Puncture resistance, lbf (N) per ASTM E154:
a) ¼ in board: 100 (445)

b. Georgia Pacific Gypsum LLC, DensDeck Prime Roof Board:
i Gypsum core, glass fiber-faced, factory primed, roof Cover-board.
ii Thickness: [5/8 in][1/2 in]
iii Dimensions: [4 x 4 ft][4 x 8 ft] boards
iv Facer: Factory primed, glass fiber.
v Meets or exceeds ASTM C1177/C1177M.

C. INSULATION CANT AND TAPERED STRIP
1. CANT STRIP, MODIFIED BITUMEN
a. SOPRACANT MB: Modified bitumen cant strips for use with COLPLY ADHESIVE, COLPLY FLASHING CEMENT, asphalt, and heat-welded SBS modified bitumen. Not for use with COLPLY EF nor self-adhered SBS modified bitumen.
i Length: 39.4 in sections.
ii Cross-section dimensions: [1.25 x 1.25 x 2 in face width][2.25 x 2.25 x 3.25 in face width]. Size as required for flashing conditions.

2. TAPERED EDGE STRIP AND BOARDS:
a. Expanded perlite, blended with binders and fibers.

i Dimensions: [6 in x 1/2 in][12 in x 1/2 in][1 in or 1-1/2 in][18 in x 1 in or 1-1/2 in]. Size as required.
ii Meets or exceeds ASTM C728.

D. INSULATION ADHESIVE
1. POLYURETHANE FOAM INSULATION ADHESIVE
a. SOPREMA DUOTACK 365: Two-component, polyurethane foam insulation adhesive, applied in ribbons from cartridges or two-component bulk packaging with pump-driven delivery system.
i Ribbon size: 1/2 in to 3/4 in wide.
ii Ribbon spacing: As required to meet specified wind uplift resistance performance.
a) Field of Roof (Zone 1'): 12 in on-centers
b) Field of Roof (Zone 1): 12 in on-centers
c) Perimeter of Roof (Zone 2): 6 in on-centers
d) Corners of Roof (Zone 3): 4 in on-centers

2.03 ACCESSORIES

A. PRIMERS:
1. SOPREMA ELASTOCOL 500 PRIMER: Asphalt cut-back primer. Primer for the preparation of substrates for asphalt applications.
a. Meets or exceeds ASTM D41
b. VOC content: 350 g/L or less.
2. SOPREMA ELASTOCOL 350 PRIMER: Polymer emulsion primer, meeting low VOC requirements for the preparation of substrates for asphalt applications.
3. SOPREMA ELASTOCOL STICK ZERO PRIMER: 0 g/L VOC solvent, self-adhesive membrane primer. Low VOC, solvent-based primer for the preparation of membrane substrates for self-adhered SBS membrane and self-adhesive SBS flashing applications.
4. SOPREMA ELASTOCOL STICK PRIMER: Self-adhesive membrane primer. SBS polymer, resin and, solvent-based primer for the preparation of membrane substrates for self-adhesive SBS membrane and self-adhered SBS flashing applications.

B. INSULATION FASTENERS AND PLATES
1. PLATE: Insulation system fasteners and metal stress plates.
2. SOPREMA #14 MP FASTENER and SOPREMA 3 IN INSULATION PLATE: Insulation system fasteners and metal stress plates.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examination includes visual observations, qualitative analysis, and quantitative testing measures as necessary to ensure conditions remain satisfactory throughout the project.
B. Conduct qualitative insulation adhesive adhesion tests, or quantitative bonded pull tests as necessary to ensure satisfactory adhesion is achieved.
C. The contractor shall examine all roofing substrates including, but not limited to: insulation materials, roof decks, walls, curbs, rooftop equipment, fixtures, and wood blocking.

D. The applicator shall not begin installation until conditions have been properly examined and determined to be clean, dry and, otherwise satisfactory to receive specified roofing materials.
E. During the application of specified materials, the applicator shall continue to examine all project conditions to ensure conditions remain satisfactory to complete the specified roofing system.

3.02 PREPARATION

A. Before commencing work each day, the contractor shall prepare all roofing substrates to ensure conditions are satisfactory to proceed with the installation of specified roofing materials. Preparation of substrates includes, but is not limited to, substrate repairs, securement of substrates, eliminating all incompatible materials, and cleaning.
B. Where conditions are found to be unsatisfactory, work shall not begin until conditions are made satisfactory to begin work. Commencing of work shall indicate contractor's acceptance of conditions.

3.03 PRIMER APPLICATION

A. Apply the appropriate specified primer to dry, compatible substrates as required to enhance adhesion of new specified roofing materials.
B. Apply primer using brush, roller, or sprayer at the rate published on the product data sheet.
C. Asphalt Primer: Apply primer to dry compatible masonry, metal, wood, and other required substrates before applying asphalt.
D. Self-Adhesive Membrane Primer: Apply self-adhered primer to dry, compatible substrates as required to enhance adhesion of self-adhesive membrane plies. Ensure self-adhered membrane primer is tacky to-the-touch, but not wet. Primer should not transfer to the fingertips when touched.
E. Project conditions vary throughout the day. Monitor changing conditions, monitor the drying time of primers, and monitor the adhesion of the membrane plies. Adjust primer and membrane application methods as necessary to achieve the desired results.

3.04 INSULATION FASTENER APPLICATION

A. Fasten [Thermal Barrier][Insulation Base Layer][Insulation][Cover-board] to the deck using specified insulation fasteners and plates.
B. Evenly distribute fasteners as required by the board manufacturer's published requirements.
C. Fasten the insulation to meet the specified wind uplift resistance performance requirements and warranty requirements.
D. Minimum insulation fastening requirement:
    1. Field of Roof (Zone 1'): 1 fastener per 0.00 square ft
    2. Field of Roof (Zone 1): 1 fastener per 0.00 square ft
    3. Perimeter of Roof (Zone 2): 1 fastener per 0.00 square ft
    4. Corners of Roof (Zone 3): 1 fastener per 0.00 square ft
E. Minimum insulation fastening requirement:
    1. Field of Roof (Zone 1'): 00 fasteners per 4x8 ft board.
    2. Field of Roof (Zone 1): 00 fasteners per 4x8 ft board.

3. Perimeter of Roof (Zone 2): 00 fasteners per 4x8 ft board.
4. Corners of Roof (Zone 3): 00 fasteners per 4x8 ft board.

F. For insulation and Cover-boards located partially within the defined perimeter and/or corners, install fastening for the entire board as specified herein.

3.05 INSULATION ADHESIVE APPLICATION

A. DUOTACK 365
1. Apply the specified two-component insulation adhesive to adhere [Insulation Base Layer][Insulation Layers][Cover-board] to the deck and insulation substrate(s).
2. Follow insulation adhesive product data sheets and published general requirements for installation requirements.
3. Apply insulation adhesive in uniform ribbons, 1/2 in to 3/4 in wide.
4. Immediately install insulation components into insulation adhesive and apply weight to ensure the materials maintain full contact with all ribbons for complete adhesion. Do not allow insulation adhesive to skin-over before placing the insulation materials into the adhesive.
5. Adhere the insulation system to meet the specified wind uplift resistance performance and specified warranty requirements.
6. Minimum insulation adhesive ribbon spacing:
a. Field of Roof (Zone 1'): 12 in on-centers.
b. Field of Roof (Zone 1): 12 in on-centers.
c. Perimeter of Roof (Zone 2): 6 in on-centers.
d. Corners of Roof (Zone 3): 4 in on-centers.

3.06 INSULATION SYSTEM APPLICATION

A. Follow insulation system component product data sheets, published general requirements and, approvals.
B. Install all insulation system components on clean, dry, uniform and, properly prepared substrates.
C. All insulation system boards shall be carefully installed and fitted against adjoining sheets to form tight joints.
D. Insulation system boards that must be cut to fit shall be saw-cut or knife-cut in a straight line, not broken. Chalk lines shall be used to cut insulation components. Uneven or broken edges shall not be accepted. Remove dust and debris that develops during cutting operations.
E. Stagger successive layers of insulation 12 in vertically and laterally to ensure board joints do not coincide with joints from the layers above and below.
F. Crickets, saddles, and tapered edge strips shall be installed before installing Cover-boards.
G. Install tapered insulation, saddles and crickets as required to ensure positive slope for complete roof drainage.
H. Cover-boards shall be installed to fit tight against adjacent boards. When required by the Cover-board manufacturer, a uniform gap shall be provided between Cover-boards using a uniform guide placed between board joints to form a gap between all boards during installation.
I. The finished insulation system surface shall be tight to, and flush with, adjacent substrates to form a satisfactory substrate to install specified roof membrane and flashings.

J. Install specified cants where required for membrane flashing transitions.

3.07 CLEAN-UP

A. Clean-up and properly dispose of waste and debris resulting from these operations each day as required to prevent damages and disruptions to operations.

END OF SECTION

SECTION 07 52 16

STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Work shall include, but is not limited to, the following:
   1. Preparation of existing concrete roof deck, and all flashing substrates.
   2. SBS-modified bitumen base ply(s), [heat-welded][cold adhesive-applied][self-adhesive][mechanically fastened].
   3. SBS-modified bitumen cap sheet, [heat-welded][cold adhesive-applied][self-adhesive].
   4. SBS-modified bitumen membrane flashings.
   5. Liquid-applied, reinforced flashings.
   6. Refer to related Sections for Insulation, Asphaltic Coverboard and Roof Edge Systems
   7. All related materials and labor required to complete specified roofing necessary to receive specified manufacturer's warranty.

1.02 RELATED SECTIONS

A. Division 010000 – General Requirements
B. Division 011000 – Summary of Work
C. Division 072200 – Roof Insulation
D. Division 076200 – Sheet Metal Flashing and Trim

1.03 DEFINITIONS

A. ASTM D 1079-Definitions of Term Relating to Roofing and Waterproofing.
B. The National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual, Fifth Edition Glossary.

1.04 REFERENCES

A. AMERICAN SOCIETY OF CIVIL ENGINEERS - Reference Document ASCE 7, Minimum Design Loads for Buildings and Other Structures.
B. AMERICAN STANDARD OF TESTING METHODS (ASTM):
   1. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants
   2. ASTM D 41 - Standard Specification for Asphalt Primer Used in Roofing, Damp proofing, and Waterproofing.
   3. ASTM D 312- Standard Specification for Asphalt Used in Roofing.
   4. ASTM D 3746 - Standard Test Method for Impact Resistance of Bituminous Roofing System.
   5. ASTM D 4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free.
   6. ASTM D 5147 - Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material.
   7. ASTM D 5849 - Standard Test Method for Evaluating Resistance of Modified Bituminous Roofing Membrane to Cyclic Fatigue (Joint

Displacement)

8. ASTM D 6164 - Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements.
9. ASTM D 7379 - Standard Test Methods for Strength of Modified Bitumen Sheet Material Laps Using Cold Process Adhesive.
10. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings.
11. ASTM E 1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

C. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI):

1. ANSI/SPRI/FM 4435/ES-1 Wind Design Standard for Edge System Used with Low Slope Roofing System.
2. ANSI/SPRI FX-1, Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.
3. ANSI/SPRI IA-1, Standard Field Test Procedure for Determining the Mechanical Uplift Resistance of Insulation Adhesives over Various Substrates.
4. ANSI/FM 4474- American National Standard for Evaluating the Simulated Wind Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures.

D. INTERNATIONAL CODES COUNCIL (ICC):

1. Latest Edition International Building Code (IBC).

E. NATIONAL ROOFING CONTRACTORS' ASSOCIATION (NRCA).

1. UL 790 Standard Test Methods for Fire Tests of Roof Coverings.
2. UL 1256 – Fire Test of Roof Deck Constructions.

1.05 ACTION SUBMITTALS

A. Product Data Sheets: Submit manufacturer's product data sheets, installation instructions and/or general requirements for each component.
B. Safety Data Sheets: Submit manufacturer's Safety Data Sheets (SDS) for each component.
C. Sample warranty from the manufacturer and contractor.
D. Provide roof plan and representative detail drawings.

1.06 INFORMATIONAL SUBMITTALS

A. Submit a letter from the roofing manufacturer indicating the contractor is an authorized applicator.

1.07 CLOSEOUT SUBMITTALS

A. Warranty: Provide manufacturers and contractor's warranties upon project completion.

1.08 QUALITY ASSURANCE

A. MANUFACTURER QUALIFICATIONS:

1. Manufacturer shall have 20 years of manufacturing experience.
2. Manufacturer shall have trained technical service representatives employed by the manufacturer, independent of sales.

3. Manufacturer shall provide site visit reports in a timely manner.

B. CONTRACTOR QUALIFICATIONS:
   1. Contractor shall be authorized by the manufacturer to install specified materials prior to the bidding period through satisfactory project completion.
   2. Applicators shall have completed projects of similar scope using same or similar materials specified.
   3. Contractor shall provide full time, on-site superintendent or foreman experienced with the specified roofing from beginning through satisfactory project completion.
   4. Applicators shall be skilled in the application methods for all materials.
   5. Contractor shall maintain a daily record, on-site, documenting material installation and related project conditions.
   6. Contractor shall maintain a copy of all submittal documents, on-site, available always for reference.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to each product data sheet or other published literature for specific requirements.
B. Deliver materials and store them in their unopened, original packaging, bearing the manufacturer's name, related standards, and any other specification or reference accepted as standard.
C. Protect and store materials in a dry, well-vented, and weatherproof location. Only materials to be used the same day shall be removed from this location.
D. When materials are to be stored outdoors, store away from standing water, stacked on raised pallets or dunnage, at least 4 in or more above ground level. Carefully cover storage with “breathable” tarpaulins to protect materials from precipitation and to prevent exposure to condensation.
E. Carefully store roof membrane materials delivered in rolls on-end with selvage edges up. Store and protect roll storage to prevent damage.
F. Properly dispose of all product wrappers, pallets, cardboard tubes, scrap, waste, and debris. All damaged materials shall be removed from job site and replaced with new, suitable materials.

1.10 SITE CONDITIONS

A. SAFETY:
   1. The contractor shall be responsible for complying with all project-related safety and environmental requirements.
   2. Heat-welding shall include heating the specified membrane ply using propane roof torches or electric hot-air welding equipment. The contractor shall determine when and where conditions are appropriate to utilize heat-welding equipment. When conditions are determined by the contractor to be unsafe to proceed, equivalent SBS-modified bitumen materials and methods shall be utilized to accommodate requirements and conditions.
   3. Refer to NRCA CERTA recommendations, local codes and building owner’s requirements for hot work operations.
   4. The contractor shall review project conditions and determine when and where conditions are appropriate to utilize the specified liquid-applied, or

semi-solid roofing materials. When conditions are determined by the contractor to be unsafe or undesirable to proceed, measures shall be taken to prevent or eliminate the unsafe or undesirable exposures and conditions, or equivalent approved materials and methods shall be utilized to accommodate requirements and conditions.

5. The contractor shall review project conditions and determine when and where conditions are appropriate to utilize the specified hot asphalt-applied materials. When conditions are determined by the contractor to be unsafe or undesirable to proceed, measures shall be taken to prevent or eliminate the unsafe or undesirable exposures and conditions, or equivalent approved materials and methods shall be utilized to accommodate requirements and conditions.
6. The contractor shall refer to product Safety Data Sheets (SDS) for health, safety, and environment related hazards, and take all necessary measures and precautions to comply with exposure requirements.

B. ENVIRONMENTAL CONDITIONS:

1. Monitor substrate temperature and material temperature, as well as all environmental conditions such as ambient temperature, moisture, sun, cloud cover, wind, humidity, and shade. Ensure conditions are satisfactory to begin work and ensure conditions remain satisfactory during the installation of specified materials. Materials and methods shall be adjusted as necessary to accommodate varying project conditions. Materials shall not be installed when conditions are unacceptable to achieve the specified results.
2. Precipitation and dew point: Monitor weather to ensure the project environment is dry before, and will remain dry, during the application of roofing materials. Ensure all roofing materials and substrates remain above the dew point temperature as required to prevent condensation and maintain dry conditions.
3. Cold adhesive application: Primer, where used, shall be fully dry before proceeding. Take all necessary measures and monitor application conditions, to ensure the adhesive and cement materials are no less than 70°F (21°C) at the point of contact with the membrane.
4. Self-adhesive membrane application: Ensure materials remain no less than 70°F (21°C) during application. Ensure conditions allow primer to remain tacky, but not wet so that primer will not transfer to finger when touched. Self-adhesive primer shall not fully dry and lose tack before applying the self-adhesive membrane. Ensure conditions remain satisfactory to achieve membrane adhesion as specified.
5. Heat-Welding Application: Take all necessary precautions and measures to monitor conditions to ensure all environmental conditions are safe to use roof torches and hot-air welding equipment. Combustibles, flammable liquids, and solvent vapors that represent a hazard shall be eliminated. Flammable primers and cleaners shall be fully dry before proceeding with heat-welding operations. Prevent or protect wood, paper, plastics, and other such combustible materials from direct exposure to open flames from roof torches. Refer to NRCA CERTA recommendations.

1.11 PERFORMANCE REQUIREMENTS

A. WIND UPLIFT RESISTANCE:

1. Performance testing shall be in accordance with ANSI/FM 4474, FM 4450, FM 4470, UL 580, or UL 1897.
    a. Roof System Design Pressures: Calculated in accordance with ASCE 7, or applicable standard, for the specified roof system attachment requirements.
    b. Design Pressures:
        i Field of Roof (Zone 1'): [- 0.00 psf.]
        ii Field of Roof (Zone 1): [- 0.00 psf.]
        iii Perimeter of Roof (Zone 2): [- 0.00 psf.]
        iv Corners of Roof (Zone 3): [- 0.00 psf.]
    c. Approval Rating:
        i FM 1-[00]

B. FIRE CLASSIFICATION:
1. Performance testing shall be in accordance with UL 790, ASTM E108, FM 4450 or FM 4470 to meet the [1/4]:12 roof slope requirement.
    a. Meets requirements of UL Class A or FM Class A.
2. Performance testing shall be in accordance with UL 1256, FM 4450 or FM 4470 to meet the specified requirements for interior flame spread and fuel contribution.
    a. Meets requirements of UL 1256, or FM Class 1.

C. ROOF SLOPE:
1. Finished roof slope for SBS modified bitumen surfaces shall be ¼ inch per foot (2 percent) minimum for roof drainage.

D. IMPACT RESISTANCE:
1. Performance testing for impact resistance shall be in accordance with FM 4450, FM 4470, ASTM D3746 or CGSB 37-GP 56M to meet the specified impact resistance requirements.
2. Performance testing for Large Missile Impact Resistance shall be in accordance with SSTD 12-99.
    a. Meets requirements for Public Shelter Design Criteria for Enhanced Hurricane Protection Areas.

E. CYCLIC FATIGUE:
1. The roof system shall pass ASTM D5849 Standard Test Method for Evaluating Resistance of Modified Bituminous Roofing Membrane to Cyclic Fatigue (Joint Displacement). Passing results shall show no signs of cracking, splitting, or tearing over the joint.
    a. Roof system shall pass Test Condition 5, tested at -4°F (-20°C) in accordance with ASTM D5849. (SOPREMA SOPRALENE polyester reinforced membranes).

1.12 WARRANTY

A. Manufacturer's No Dollar Limit (NDL) Warranty. The manufacturer shall provide the owner with the manufacturer's warranty providing labor and materials for 20 years from the date the warranty is issued.

B. The contractor shall guarantee the workmanship and shall provide the owner with the contractor's warranty covering workmanship for a period of 5 years from completion date.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. SINGLE SOURCE MANUFACTURER: All SBS modified bitumen membrane and flashing sheets shall be manufactured by a single supplier with 20 years or more manufacturing history in the US.
   1. Comply with the Manufacturer's requirements as necessary to provide the specified warranty.

B. PRODUCT QUALITY ASSURANCE PROGRAM: Manufacturer shall be an ISO 9001 registered company. A 'Quality Compliance Certificate (QCC) for reporting/confirming the tested values of the SBS-Modified Bitumen Membrane Materials will be supplied upon request.

C. ACCEPTABLE MANUFACTURER:
   1. SOPREMA, located at: 310 Quadral Dr.; Wadsworth, OH 44281; Tel: 800-356-3521; Tel: 330-334-0066; 787-413-2400 Website: www.soprema.us.
   2. Acceptable Alternate Manufacturers: Approved equal by Project Architect

2.02 ROOFING SYSTEM

A. ROOFING SYSTEM BASIS OF DESIGN: SOPREMA
   1. The roof membrane assembly shall consist of a multi-ply, prefabricated, reinforced, homogeneous Styrene-Butadiene-Styrene (SBS) block copolymer modified asphalt membrane, secured to a prepared substrate. Reinforcement mats shall be impregnated (saturated) and coated with a high quality SBS modified bitumen blend. The cross section of the sheet material shall contain no oxidized or non-SBS modified bitumen.

2.03 SBS-MODIFIED BITUMEN MEMBRANES

A. TEMPORAY BASE SHEET MEMBRANE TORCH * OPTION SELF ADHERED
   1. TORCHED BASE SHEET
      a. SOPREMA SOPRALENE 180 SP 3.0: SBS-modified bitumen membrane with a plastic burn-off film on the bottom surface and a sanded top surface. Non-woven polyester reinforcement. Meets or exceeds ASTM D6164, Type I, Grade S, per ASTM D5147 test methods:
         i Thickness: 118 mils (3.0 mm)
         ii Width: 39.4 in (1 m)
         iii Length: 32.8 ft (10 m)
         iv Roll weight: 83 lb (37.6 kg)
         v Net mass per unit area, lb/100 sq ft (g/sq m): 77 lb (3758 g)
         vi Peak load @ 0°F (-18°C), lbf/in (kN/m): MD 115 lbf/in (20.1 kN/m), XMD 90 lbf/in (15.8 kN/m)
         vii Elongation at peak load @ 0°F (-18°C), lbf/in (kN/m): MD 35%, XMD 40%
         viii Peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 85 lbf/in (14.9 kN/m), XMD 65 lbf/in (11.4 kN/m)
         ix Elongation at peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 55%, XMD 60%
         x Ultimate Elongation @ 73.4°F (23°C), lbf/in (kN/m): MD 65%, XMD 80%

xi Tear Strength @ 73.4°F (23°C), lbf (N): MD 125 lbf (556 N), XMD 85 lbf (378 N)

xii Low temperature flexibility, °F (°C): MD/XMD: -15°F (-26°C)

b. *SELF ADHERED SOPRALENE ULTRA-STICK: SBS-modified bitumen, self-adhesive membrane with release film on the bottom surface and a permanent film top surface. Non-woven polyester reinforced. Meets or exceeds ASTM D6164, Type I, Grade S, per ASTM D5147 test methods:

i Thickness: 102 mils (2.6 mm)

ii Width: 39.4 in (1 m)

iii Length: 49.2 ft (15 m)

iv Roll weight: 108 lb (48.9 kg)

v Peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 75 lbf/in (13.1 kN/m), XMD 50 lbf/in (8.8 kN/m)

vi Elongation at peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 75%, XMD 75%

vii Ultimate Elongation @ 73.4°F (23°C), lbf/in (kN/m): MD 110%, XMD 110%

viii Tear Strength @ 73.4°F (23°C), lbf (N): MD 115 lbf (511 N), XMD 90 lbf (400 N)

ix Low temperature flexibility, °F (°C): MD/XMD: -15°F (-26°C)

x Dimensional stability, %: MD/XMD: Less than 0.05%

xi Dimensional stability, %: MD/XMD: Less than 0.5%

xii Compound stability, °F (°C): MD/XMD: 240°F (116°C)

B. BASE PLY:

1. BASE PLY, HEAT-WELDED OVER COVER BOARD:

a. SOPREMA SOPRALENE FLAM 180: SBS-modified bitumen membrane with plastic burn-off film on top and bottom surfaces. Non-woven polyester reinforcement. Meets or exceeds ASTM D6164, Type I, Grade S, per ASTM D5147 test methods:

i Thickness: 118 mils (3.0 mm)

ii Width: 39.4 in (1 m)

iii Length: 32.8 ft (10 m)

iv Roll weight: 81 lb (36.7 kg)

v Net mass per unit area, lb/100 sq ft (g/sq m): 75 lb (3662 g)

vi Peak load @ 0°F (-18°C), lbf/in (kN/m): MD 115 lbf/in (20.1 kN/m), XMD 90 lbf/in (15.8 kN/m)

vii Elongation at peak load @ 0°F (-18°C), lbf/in (kN/m): MD 35%, XMD 40%

viii Peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 85 lbf/in (14.9 kN/m), XMD 65 lbf/in (11.4 kN/m)

ix Elongation at peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 55%, XMD 60%

x Ultimate Elongation @ 73.4°F (23°C), lbf/in (kN/m): MD 65%, XMD 80%

xi Tear Strength @ 73.4°F (23°C), lbf (N): MD 125 lbf (556 N), XMD 85 lbf (378 N)
xii Low temperature flexibility, °F (°C): MD/XMD: -15°F (-26°C)
xiii Dimensional stability, %: MD/XMD: Less than 0.5%
xiv Compound stability, °F (°C): MD/XMD: 240°F (116°C)

C. FLASHING BASE PLY
1. FLASHING BASE PLY, HEAT-WELDED:
a. SOPREMA SOPRALENE FLAM 180: SBS-modified bitumen membrane with plastic burn-off film on top and bottom surfaces. Non-woven polyester reinforcement. Meets or exceeds ASTM D6164, Type I, Grade S, per ASTM D5147 test methods:
i Thickness: 118 mils (3.0 mm)
ii Width: 39.4 in (1 m)
iii Length: 32.8 ft (10 m)
iv Roll weight: 81 lb (36.7 kg)
v Net mass per unit area, lb/100 sq ft (g/sq m): 75 lb (3662 g)
vi Peak load @ 0°F (-18°C), lbf/in (kN/m): MD 115 lbf/in (20.1 kN/m), XMD 90 lbf/in (15.8 kN/m)
vii Elongation at peak load @ 0°F (-18°C), lbf/in (kN/m): MD 35%, XMD 40%
viii Peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 85 lbf/in (14.9 kN/m), XMD 65 lbf/in (11.4 kN/m)
ix Elongation at peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 55%, XMD 60%
x Ultimate Elongation @ 73.4°F (23°C), lbf/in (kN/m): MD 65%, XMD 80%
xi Tear Strength @ 73.4°F (23°C), lbf (N): MD 125 lbf (556 N), XMD 85 lbf (378 N)
xii Low temperature flexibility, °F (°C): MD/XMD: -15°F (-26°C)
xiii Dimensional stability, %: MD/XMD: Less than 0.5%
xiv Compound stability, °F (°C): MD/XMD: 240°F (116°C)

D. CAP SHEET:
1. CAP SHEET, HEAT-WELDED:
a. SOPREMA SOPRALENE FLAM 180 FR GR: SBS-modified bitumen membrane Cap Sheet with a burn-off film bottom surface and mineral granule top surface. Non-woven polyester reinforced. UL Class A for specified roof slope requirements. Meets or exceeds ASTM D6164, Type I, Grade G, per ASTM D5147 test methods:
i Thickness: 157 mils (4.0 mm)
ii Width: 39.4 in (1 m)
iii Length: 32.8 ft (10 m)
iv Roll weight: 118 lb (53.5 kg)
v Net mass per unit area, lb/100 sq ft (g/sq m): 110 lb (5371 g)
vi Peak load @ 0°F (-18°C), lbf/in (kN/m): MD 115 lbf/in (20.1 kN/m), XMD 90 lbf/in (15.8 kN/m)

vii Elongation at peak load @ 0°F (-18°C), lbf/in (kN/m): MD 35%, XMD 40%
viii Peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 85 lbf/in (14.9 kN/m), XMD 65 lbf/in (11.4 kN/m)
ix Elongation at peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 55%, XMD 60%
x Ultimate Elongation @ 73.4°F (23°C), lbf/in (kN/m): MD 65%, XMD 80%
xi Tear Strength @ 73.4°F (23°C), lbf (N): MD 125 lbf (556 N), XMD 85 lbf (378 N)
xii Low temperature flexibility, °F (°C): MD/XMD: -15°F (-26°C)
xiii Dimensional stability, %: MD/XMD: Less than 0.5%
xiv Compound stability, °F (°C): MD/XMD: 240°F (116°C)
xv Granule Surfacing:
a) White mineral granules.

b. SOPREMA SOPRALAST 50 TV ALU: SBS-modified bitumen membrane Cap Sheet with a plastic burn-off film bottom surface and aluminum foil-clad top surface. Glass grid reinforced. UL Class A for specified roof slope requirements. All SBS modified bitumen foil-clad membrane and flashing sheets shall be manufactured by the supplier. Meets or exceeds ASTM D6298, per ASTM D5147 test methods:
i Thickness: 157 mils (4.0 mm)
ii Width: 39.4 in (1 m)
iii Length: 32.8 ft (10 m)
iv Roll weight: 94 lb (42.7 kg)
v Net mass per unit area, lb/100 sq ft (g/sq m): 87.5 lb (4273 g)
vi Peak load @ 0°F (-18°C), lbf/in (kN/m): MD 200 lbf/in (35.2 kN/m), XMD 175 lbf/in (30.8 kN/m)
vii Elongation at peak load @ 0°F (-18°C), lbf/in (kN/m): MD 10%, XMD 10%
viii Peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 95 lbf/in (16.7 kN/m), XMD 95 lbf/in (16.7 kN/m)
ix Elongation at peak load @ 73.4°F (23°C), lbf/in (kN/m): MD 20%, XMD 20%
x Ultimate Elongation @ 73.4°F (23°C), lbf/in (kN/m): MD 50%, XMD 50%
xi Tear Strength @ 73.4°F (23°C), lbf (N): MD 190 lbf (845 N), XMD 205 lbf (912 N)
xii Low temperature flexibility, °F (°C): MD/XMD: -15°F (-26°C)
xiii Dimensional stability, %: MD/XMD: Less than 0.2%
xiv Compound stability, °F (°C): MD/XMD: 230°F (110°C).

2. FLASHING CAP SHEET, LIQUID-APPLIED:
a. SOPREMA ALSAN RS 230 FLASH: Catalyzed polymethyl methacrylate (PMMA) liquid resin with polyester reinforcing fleece fabric fully embedded into the resin to form fully reinforced

waterproofing membrane flashings. All LIQUID-APPLIED flashing shall be manufactured by the single-sourced membrane supplier.

i VOC Content: <5 g/l

ii SOPREMA ALSAN RS 230 FLASH: Polymethyl methacrylate (PMMA) liquid resin.

iii SOPREMA ALSAN RS CATALYST POWDER: Reactive agent added to the liquid resin to induce polymerization.

iv SOPREMA ALSAN RS FLEECE: Polyester reinforcement fabric.

v Color: Flash color and finish to match Field.

2.04 ACCESSORIES

A. PRIMERS:

1. SOPREMA ELASTOCOL 500 Primer: Asphalt cut-back primer. Primer for the preparation of membrane substrates for asphalt, heat-welded, hot asphalt and COLPLY ADHESIVE, solvent-based, cold adhesive-applied and cement applications.
   a. Meets or exceeds ASTM D41
   b. VOC content: 350 g/L or less.
2. SOPREMA ELASTOCOL 350 Primer: Polymer emulsion primer, meeting low VOC requirements for the preparation of membrane substrates for hot asphalt, torch and SOPREMA COLPLY adhesive and flashing cement applications.
3. SOPREMA ELASTOCOL STICK ZERO Primer: 0 g/L VOC solvent, self-adhesive membrane primer. Low VOC, solvent-based primer for the preparation of membrane substrates for self-adhered SBS membrane and self-adhesive SBS flashing applications.
4. SOPREMA ELASTOCOL STICK Primer: Self-adhesive membrane primer. SBS polymer, resin and, solvent-based primer for the preparation of membrane substrates for self-adhesive SBS membrane and self-adhered SBS flashing applications.
5. SOPREMA ELASTOCOL STICK H2O: Self-adhesive membrane primer. Water based polymer emulsion primer for the preparation of membrane substrates for self-adhesive SBS membrane and self-adhered SBS flashing applications.
6. SOPREMA ALSAN RS 222 PRIMER: Rapid curing, polymethyl methacrylate (PMMA) liquid resin used to promote adhesion of PMMA/PMA membranes over asphaltic substrates, wood, concrete and approved waterproofing board substrates.
   a. VOC content: 2.5 g/L
   b. Color: Clear
7. SOPREMA ALSAN RS LO PRIMER: Low odor, two-part, epoxy-based primer for concrete and approved substrates.
   a. SOPREMA ALSAN RS LO PRIMER PART A:
      i VOC content: <100 g/L
      ii Color: Ivory
   b. SOPREMA ALSAN RS LO PRIMER PART B:
      i VOC content: <100 g/L
      ii Color: White
8. SOPREMA ALSAN RS METAL PRIMER: Solvent-based primer used to

improve the adhesion of PMMA/PMA membranes to metal substrates.
a. VOC content: 550 g/L
b. Color: Off White

B. MEMBRANE ADHESIVES:
1. SOPREMA COLPLY ADHESIVE: SBS-modified bitumen membrane adhesive for use with sanded base ply and granule-surfaced Cap Sheet membranes.
a. VOC Content: 250 g/L or less.
b. Meets or exceeds ASTM D3019
2. SOPREMA COLPLY EF ADHESIVE: Premium, non-toxic, low odor, solvent-free, polymeric membrane adhesive for use with all SBS-modified bitumen sanded base ply and all Cap Sheet membrane applications.
a. VOC Content: 32 g/L or less VOC Content.
b. Meets or exceeds ASTM D7379

C. FLASHING CEMENT:
1. SOPREMA COLPLY FLASHING CEMENT: SBS-modified bitumen membrane flashing cement for use with sanded base ply flashing and granule-surfaced Cap Sheet flashing.
a. VOC Content: 250 g/L or less.
b. Meets or exceeds ASTM D4586
2. SOPREMA COLPLY EF FLASHING CEMENT: Premium, non-toxic, low-odor, solvent-free, polymeric membrane flashing cement for use with sanded base ply and all sanded cap sheet flashing applications.
a. VOC Content: 32 g/L or less VOC Content.

D. GENERAL PURPOSE ROOFING CEMENT AND MASTIC:
1. SOPREMA SOPRAMASTIC: SBS Mastic. Fiber-reinforced, roofing cement, packaged in 5-gallon pails. General purpose roofing cement for low-slope roofing used for sealing membrane T-joints and membrane edges along terminations, transitions and at roof penetrations.
a. VOC Content: 190 g/L or less.
b. Meets or exceeds ASTM D4586, Type I, Class II.
2. SOPREMA SOPRAMASTIC: SBS Mastic. Fiber-reinforced, roofing cement, packaged in 10.4 oz caulk tubes. General purpose roofing cement for low-slope roofing used for sealing membrane T-joints and membrane edges along terminations, transitions and at roof penetrations.
a. VOC Content: 190 g/L or less.
b. Meets or exceeds ASTM D4586, Type I, Class II.

E. GENERAL PURPOSE SEALANT
1. SOPREMA SOPRAMASTIC SP1: General purpose, paintable, gun-grade, elastomeric, polyether moisture curing sealant for sealing SBS membrane terminations, Kynar 500 PVDF, horizontal and vertical construction joints.
a. VOC Content: 20 g/L or less.
b. Meets or exceeds ASTM C920, Type S, Grade NS, Class 50.
c. Standard color, custom color.
2. SOPREMA SOPRAMASTIC ALU: Modified bitumen mastic, aluminum hued for application to membrane edge and perimeter metal.
a. VOC Content: 270 g/L or less.
b. Standard color.

F. MEMBRANE FASTENERS AND PLATES
1. SOPREMA #14 MP Fastener: Membrane base ply fastener.

2. SOPREMA 2.4 in SEAM PLATE: Membrane base ply seam plate.
3. SOPREMA TRI-FIXX FASTENING SYSTEM: Membrane base ply fastening system consisting of three (3) pneumatically driven nails per 3 in metal seam plate.

G. LIQUID-APPLIED REINFORCED FLASHING SYSTEM:
1. SOPREMA ALSAN FLASHING: Single-component, polyurethane-bitumen resin with polyester reinforcing fleece fabric fully embedded into the resin to form roof system flashings.
   a. VOC Content: 250 g/L.
   b. SOPREMA ALSAN FLASHING: Liquid resin, Meets or exceeds ASTM C836.
   c. SOPREMA ALSAN POLYFLEECE: Non-woven polyester reinforcement.
   d. Surfacing: SOPREMA ALSAN FLASHING with mineral granules broadcast into wet SOPREMA ALSAN FLASHING to match adjacent SBS-modified bitumen cap sheet.
2. SOPREMA ALSAN RS 230 FLASH: Rapid curing, polymethyl methacrylate (PMMA) liquid resin with an embedded polyester reinforcement fabric used for monolithic waterproofing flashing membranes. Not for use over SBS cap sheets adhered with solvent based SOPREMA COLPLY adhesive or flashing cement.
   a. VOC content: 4.2 g/L
   b. SOPREMA ALSAN RS CATALYST POWDER: Reactive agent added to the PMMA liquid resin to induce curing.
   c. SOPREMA ALSAN RS FLEECE: Polyester reinforcement fabric.
   d. Color: [White][Grey][Custom Color]

H. MINERAL GRANULES:
1. SOPREMA Granules: No. 11, mineral coated colored granules, color to match cap sheet, supplied by membrane cap sheet manufacturer.
   a. SOPREMA GRANULES

I. EXPANSION JOINT:
1. SOPREMA SOPRAJOINT: Low-profile, polyester knit-reinforced, SBS-modified bitumen expansion joint membrane. Top surface consists of an aluminum-clad bond-breaker, with plastic burn-off film on the bottom surface for torch or hot air welding.
   a. Thickness: 160 mils (4.0 mm)
   b. Width: 18 in (457 mm)
   c. Roll Length: 32.8 ft (10 m)
   d. Expansion joint, maximum unsupported span: 2 in (51 mm)
   e. Expansion joint, maximum displacement: 5/8 in (16 mm)

J. WALKWAY PROTECTION:
1. SOPREMA SOPRAWALK: Polyester reinforced SBS modified bitumen walkway protection with a granule surface and sanded underside.
   a. Thickness: 200 mils (5.0 mm)
   b. Width: 39.4 in (1 m)
   c. Roll Length: 26 ft (7.9 m)
   d. Granule Surfacing:
      i Color: [Black][Grey][Tan]

PART 3 EXECUTION

3.01 EXAMINATION

A. Examination includes visual observations, qualitative analysis, and quantitative testing measures as necessary to ensure conditions remain satisfactory throughout the project.
B. The contractor shall examine all roofing substrates including, but not limited to insulation materials, roof decks, walls, curbs, rooftop equipment, fixtures, and wood blocking.
C. The applicator shall not begin installation until conditions have been properly examined and determined to be clean, dry and, otherwise satisfactory to receive specified roofing materials.
D. During the application of specified materials, the applicator shall continue to examine all project conditions to ensure conditions remain satisfactory to complete the specified roofing system.

3.02 PREPARATION

A. Before commencing work each day, the contractor shall prepare all roofing substrates to ensure conditions are satisfactory to proceed with the installation of specified roofing materials. Preparation of substrates includes, but is not limited to, substrate repairs, securement of substrates, eliminating all incompatible materials, and cleaning.
B. Where conditions are found to be unsatisfactory, work shall not begin until conditions are made satisfactory to begin work. Commencing of work shall indicate contractor's acceptance of conditions.

3.03 PRIMER APPLICATION

A. Examine all substrates, and conduct adhesion peel tests as necessary, to ensure satisfactory adhesion is achieved.
B. Apply the appropriate specified primer to dry, compatible substrates as required to enhance adhesion of new specified roofing materials.
C. Apply primer using brush, roller, or sprayer at the rate published on the product data sheet. Lightly prime for uniform coverage, do not apply heavy or thick coats of primer.
D. Asphalt Primer: Apply [SOPREMA ELASTOCOL 500][SOPREMA ELASTOCOL 350] primer to dry compatible masonry, metal, wood and other required substrates before applying asphalt and heat-welded membrane plies. Primer is optional for solvent based solvent based SBS adhesives and cements. Refer to product data sheets.
E. Self-Adhesive Membrane Primer: Apply [SOPREMA ELASTOCOL STICK][SOPREMA ELASTOCOL STICK ZERO] to dry, compatible substrates as required to enhance adhesion of self-adhesive membrane plies. Ensure self-adhered membrane primer is tacky to-the-touch, but not wet. Primer should not transfer to the fingertips when touched.
F. Primer is not required for SOPREMA COLPLY EF ADHESIVE and SOPREMA COLPLY EF FLASHING CEMENT.
G. Project conditions vary throughout the day. Monitor changing conditions, monitor the drying time of primers, and monitor the adhesion of the membrane plies. Adjust primer and membrane application methods as necessary to achieve the desired results.

3.04 HEAT WELDING

A. The Contractor is responsible for project safety. Where conditions are deemed unsafe to use open flames, manufacturer's alternate membrane application methods shall be used to install SBS modified bitumen membrane and flashings. Acceptable alternate installation methods include hot asphalt, cold adhesive-applied, self-adhered membranes and mechanically fastened plies. Hot-air welding equipment may be used in lieu of roof torches to seal membrane side and end laps where heat welding the laps is necessary. Refer to NRCA CERTA, local codes and building owner's requirements for hot work operations.

B. Single or multi-nozzle, hand-held propane roof torches shall be used to install heat-welded membrane and flashing plies. Multi-nozzle carts (dragon wagons) may also be utilized to install membrane plies. Seven (7) nozzle carts are recommended for more uniform heat application in lieu of five (5) nozzle carts.

3.05 HEAT-WELDED, FULLY ADHERED MEMBRANE APPLICATION

A. Follow material product data sheets and published general requirements for installation instructions.

B. Ensure environmental conditions are safe and satisfactory, and will remain safe and satisfactory, during the application of the heat-welded membrane and flashings.

C. Ensure all primers are fully dry before beginning heat-welding operations.

D. Unroll membrane onto the roof surface and allow time to relax prior to heat welding.

E. Starting at the low point of the roof, lay out the membrane to ensure the plies are installed perpendicular to the roof slope, shingled to prevent back-water laps.

F. Ensure all roofing and flashing substrates are prepared and acceptable to receive the heat-welded membrane.

G. Cut membrane to working lengths and widths to conform to rooftop conditions and lay out to always work to a selvage edge.

H. Ensure specified side-laps and end-laps are maintained. End-laps should be staggered 3 ft apart.

I. Direct roof torch on the roll as necessary to prevent overheating and damaging the membrane and substrates.

J. As the membrane is unrolled, apply heat to the underside of the membrane until the plastic burn-off film melts away. Continuously move the torch side-to-side across the underside of the roll to melt the bitumen on the underside of the sheet, while continuously unrolling membrane.

K. While unrolling and heating the sheet, ensure approximately ¼ to 1/2 in of hot bitumen flows ahead of the roll as it is unrolled, and there is 1/8 to 1/4 in bleed out at all laps.

L. Adjust the application of heat to the underside of the membrane and to substrate as required for varying substrates and environmental conditions.

M. At the 6 in end-laps, melt the plastic burn-off film from the top surface or embed granules and remove surfacing, where present, using a torch or hot-air welder.

N. At end-laps where T-Joints exist, cut a 45-degree dog-ear away from the selvage edge.

O. Each day, physically inspect all side and end-laps, and ensure the membrane is sealed watertight. Where necessary, use a torch or hot-air welder and a clean trowel to ensure all laps are fully sealed.

P. Inspect the installation each day to ensure the plies are fully adhered. Repair all voids, wrinkles, open laps, and all other deficiencies.

Q. Offset cap sheet side and end-laps away from the base ply laps so that cap sheet laps are not located within 18 in of base ply laps.

3.06 FLASHING APPLICATION, HEAT WELDED

A. Refer to SBS manufacturer's membrane application instructions, flashing detail drawings, and follow product data sheets and other published requirements for installation instructions. Refer to manufacturer's membrane flashing detail drawings.

B. The contractor is responsible for project safety. Refer to NRCA CERTA recommendations and building owner requirements for hot work operations.

C. Where required to seal substrates for fire safety, install specified adhered, self-adhered or fastened backer ply to the substrate. Ensure backer-ply covers and seals all substrates requiring protection from exposure to torch operations.

D. Ensure all flashing substrates that require primer are primed, and the primer is fully dry.

E. Unroll the flashing base ply and flashing cap sheet onto the roof surface to their complete length. Once relaxed, cut the membrane to the required working lengths to accommodate the flashing height, cants, and the required over-lap onto the horizontal roof surface.

F. Cut the flashing membrane from the end of the roll to always install flashings to the side-lap line or selvage edge line.

G. Lay out the flashing base ply and flashing Cap Sheet to offset all side-laps a minimum of 12 inches so that side-laps are never aligned on top of the ply beneath. Shingle the flashing ply laps to prevent back-water laps.

H. Install non-combustible cant strips at transitions where required.

I. Ensure correct membrane and flashing sequencing to achieve redundant, multi-ply, watertight flashings.

J. ROOF MEMBRANE BASE PLY:

1. Before installing flashings, install the roof membrane base ply in the horizontal field of the roof, and extend the base ply up to the top of the cant, where present, at roof terminations, transitions, and penetrations.

K. FLASHING BASE PLY:

1. Install the flashing base ply starting at the top leading edge of the vertical flashing substrate, down over the cant and onto the horizontal surface of the roof a minimum of 3 inches beyond the of base of the cant onto the roof. Cut the base ply at corners to form 3-inch side-laps. Install gussets to seal corner transitions.
2. Install one or more flashing base ply(s) at all roof terminations, transitions, and penetrations.

L. ROOF MEMBRANE CAP SHEET:

1. Install the roof membrane Cap Sheet in the horizontal field of the roof over the flashing base ply up to the roof termination, transition, or penetration, and up to the top of cants where present.
2. Using a chalk line, mark a line on the membrane cap sheet a minimum of 4 inches from the base of the cant onto the roof. Where granules are present, embed the cap sheet granules using a torch and trowel or granule embedder to prepare the surface to receive the flashing cap sheet.

M. FLASHING CAP SHEET:
   1. Install the flashing Cap Sheet starting at the top leading edge on the vertical substrate, over the cant and onto the roof surface 4 inches from the base of the cant onto the roof.
   2. Install the flashing Cap Sheet to ensure a minimum two (2) ply flashing system is present at all roof terminations, transitions, and penetrations.

N. During the membrane and flashing installation, ensure all plies are completely adhered into place, with no bridging, voids, or openings. Ensure bitumen or flashing cement bleed-out is present at all flashing side and end-laps.

O. Use a damp sponge float or damp rag to press-in the heat-welded flashing plies during installation.

P. Where sufficient bitumen bleed-out is not present, and for all self-adhered plies, apply specified gun-grade sealant or mastic to seal the membrane termination along all roof terminations, transitions, and penetrations. These include gravel stop edge metal, pipe penetrations, along the top edge of curb and wall flashing, and all other flashing terminations where necessary to seal flashings watertight.

Q. Fasten the top leading edge of the flashing 8 in on-centers with appropriate 1 in metal cap nails or other specified fasteners and plates. Seal fastener penetrations watertight using specified sealant or mastic.

R. Manufacturer's liquid-applied, reinforced flashing systems shall be installed where conditions are not favorable to install SBS modified bitumen flashings. Such conditions include irregular shapes penetrating roof surfaces (I-beams), confined areas and low flashing heights. Manufacturer's liquid-applied, reinforced flashing systems are recommended in lieu of pitch pans and lead pipe flashings.

3.07 LIQUID-APPLIED, SINGLE-COMPONENT, BITUMEN-URETHANE FLASHING SYSTEM APPLICATION

A. Refer to manufacturer's details drawings, product data sheets and published general requirements for application rates and specific installation instructions

B. Pre-cut SOPREMA ALSAN POLYFLEECE polyester reinforcing fleece to conform to roof terminations, transitions and penetrations being flashed. Ensure a minimum 2 in overlap of fleece at side and end-laps. Ensure the completed liquid-applied flashing membrane is fully reinforced.

C. Apply the base coat of SOPREMA ALSAN FLASHING liquid-applied flashing resin onto the substrate using a brush or roller, working the material into the surface for complete coverage and full adhesion at 2.0 gallons per square.

D. Immediately apply the SOPREMA ALSAN POLYFLEECE reinforcing into the wet base coat of resin. Using a brush or roller, work the SOPREMA ALSAN POLYFLEECE into the wet resin while applying the second coat of SOPREMA ALSAN FLASHING resin to completely encapsulate the fleece at 2.0 gallons per square, and extend the liquid resin 1 inch beyond the fleece.

E. Apply a finish coat of SOPREMA ALSAN FLASHING resin at 2.0 gallons per square within 2-3 hours. When applying the finish coat more than 24 hours, the surface may need to be cleaned using acetone or MEK to ensure satisfactory adhesion.

F. Broadcast mineral granules into the wet finish coat as required to match the adjacent cap sheet.

3.08 LIQUID-APPLIED, PMMA (PMA) MEMBRANE AND FLASHING SYSTEM

A. Refer to manufacturer's details drawings, product data sheets and published general requirements for application rates and specific installation instructions.
B. Pre-cut SOPREMA ALSAN RS FLEECE polyester reinforcing fleece to conform to roof terminations, transitions and penetrations being flashed. Ensure a minimum 2 in overlap of fleece at side and end-laps. Ensure the completed liquid-applied flashing membrane is fully reinforced.
C. Apply the base coat of catalyzed SOPREMA ALSAN RS resin onto the substrate using a brush or roller, working the material into the surface for complete coverage and full adhesion.
D. Immediately apply the SOPREMA ALSAN RS FLEECE reinforcing into the wet base coat of resin. Using a brush or roller, work the SOPREMA ALSAN FLEECE reinforcing fabric into the wet resin while applying the second coat of catalyzed SOPREMA ALSAN RS resin to completely encapsulate the fleece.
E. Refer to reinforced, [polymethyl-methacrylate (PMMA)][polymethacrylate (PMA)] specification section and application instructions, details drawings, product data sheets and published general requirements for installation instructions.

3.09 WALKWAYS

A. At areas outlined on the drawings, and around the perimeter of all rooftop equipment and at all door and stair landings, install walkway protection.
B. Cut walkway from end of rolls. No piece shall be less than 24 in and no more than 60 in.
C. Remove foil/film or embed granules where present on cap sheet.
D. Provide a 4 in space between sheets for drainage.
E. Locate walkway membranes a minimum of 2 in from side-laps, end-laps and flashing membranes.
F. Fully adhere walkway protection by heat welding or adhering the field with cold adhesive and heat welding a 3 in perimeter.
G.

3.10 CLEAN-UP

A. Clean-up and properly dispose of waste and debris resulting from these operations each day as required to prevent damages and disruptions to operations.

END OF SECTION

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SUMMARY

A. Work shall include, but is not limited to, the following:
   1. Preparation of [existing][new] substrates.
   2. Sheet metal flashings and sheet metal roof edge system.
   3. All related materials and labor required to complete specified roofing necessary to receive specified manufacturer's warranty.

1.02 RELATED SECTIONS

A. Division 011000 – Summary of Work
B. Division 072200 – Roof Insulation
C. Division 072713 – Modified Bituminous Sheet Vapor Retarders
D. Division 075216 – Styrene-Butadiene-Styrene (SBS) Modified Bitumen Membrane Roofing

1.03 DEFINITIONS

A. ASTM D 1079-Definitions of Term Relating to Roofing, Waterproofing and Waterproofing.
B. The National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual, Fifth Edition Glossary.

1.04 REFERENCES

A. AMERICAN SOCIETY OF CIVIL ENGINEERS - Reference Document ASCE 7, Minimum Design Loads for Buildings and Other Structures.
B. AMERICAN STANDARD OF TESTING METHODS (ASTM):
   1. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants
   2. ASTM D 41 - Standard Specification for Asphalt Primer Used in Roofing, Damp proofing, and Waterproofing.
   3. ASTM D 4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free.
C. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)::
   1. ANSI/SPRI/FM 4435/ES-1 Wind Design Standard for Edge System Used with Low Slope Roofing System.
   2. ANSI/SPRI FX-1, Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.
D. INTERNATIONAL CODES COUNCIL (ICC):
   1. Latest Edition International Building Code (IBC).
E. NATIONAL ROOFING CONTRACTORS' ASSOCIATION (NRCA) Roofing and Waterproofing Manual.
F. SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION INC. (SMACNA) Architectural Sheet Metal Manual.

1.05 ACTION SUBMITTALS

A. Product Data Sheets: Submit manufacturer’s product data sheets, installation instructions and/or general requirements for each component.
B. Safety Data Sheets: Submit manufacturer’s Safety Data Sheets (SDS) for each component.
C. Sample/Specimen Warranty from the manufacturer and contractor.
D. Shop Drawings: Provide roof plan and applicable roof system detail drawings.

1.06 INFORMATIONAL SUBMITTALS

A. Contractor Certification: Submit written certification from roofing system manufacturer certifying that the applicator is authorized by the manufacturer to install the specified materials and system.

1.07 CLOSEOUT SUBMITTALS

A. Warranty: Provide manufacturers and contractor’s warranties upon substantial completion of the roofing system.

1.08 QUALITY ASSURANCE

A. MANUFACTURER QUALIFICATIONS:
   1. Manufacture shall have 20 years of experience manufacturing roofing materials.
   2. Trained Technical Field Representatives, employed by the manufacturer, independent of sales.
   3. Provide reports in a timely manner of all site visit reports.
   4. Provide specified warranty upon satisfactory project completion.
B. CONTRACTOR QUALIFICATIONS:
   1. Contractor shall be authorized by the manufacturer to install specified materials prior to the bidding period through satisfactory project completion.
   2. Applicators shall have completed projects of similar scope using same materials as specified herein.
   3. Contractor shall provide full time, on-site superintendent or foreman experienced with the specified roof system through satisfactory project completion.
   4. Applicators shall be skilled in the application methods for all materials.
   5. Contractor shall maintain a daily record, on-site, documenting material installation and related project conditions.
   6. Contractor shall maintain a copy of all submittal documents, on-site, available always for reference.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to each product data sheet or other published literature for specific requirements.
B. Deliver materials and store them in their unopened, original packaging, bearing the manufacturer's name, related standards, and any other specification or reference accepted as standard.

C. Protect and store materials in a dry, well-vented, and weatherproof location. Only materials to be used the same day shall be removed from this location.

D. When materials are to be stored outdoors, store away from standing water, stacked on raised pallets or dunnage, at least 4 in or more above ground level. Carefully cover storage with “breathable” tarpaulins to protect materials from precipitation and to prevent exposure to condensation.

E. Properly dispose of all product wrappers, pallets, cardboard tubes, scrap, waste, and debris. All damaged materials shall be removed from job site and replaced with new, suitable materials.

1.10 SITE CONDITIONS

A. SAFETY:
   1. The contractor shall be responsible for complying with all project-related safety and environmental requirements.
   2. The contractor shall refer to product Material Safety Data Sheets (MDS) for health, safety, and environment related hazards, and take all necessary measures and precautions to comply with exposure requirements.

B. ENVIRONMENTAL CONDITIONS:
   1. Monitor substrate temperature and material temperature, as well as all environmental conditions such as ambient temperature, moisture, sun, cloud cover, wind, humidity, and shade. Ensure conditions are satisfactory to begin work and ensure conditions remain satisfactory during the installation of specified materials. Materials and methods shall be adjusted as necessary to accommodate varying project conditions. Materials shall not be installed when conditions are unacceptable to achieve the specified results.
   2. Precipitation and dew point: Monitor weather to ensure the project environment is dry before, and will remain dry, during the application of roofing materials. Ensure all roofing materials and substrates remain above the dew point temperature as required to prevent condensation and maintain dry conditions.

1.11 PERFORMANCE REQUIREMENTS

A. ROOF EDGE SYSTEM:
   1. Performance testing shall be in accordance with ANSI/SPRI/FM 4435/ES-1 Wind Design Standard for Edges Systems Used with Low Slope Roofing Systems.
      a. Wind Load Determination:
         i Perimeter Region:
            a) Horizontal: [-00.0] psf
            b) Vertical: [-00.0] psf
         ii Corners Region:
            a) Horizontal: [-00.0] psf
            b) Vertical: [-00.0] psf

PART 2 PRODUCTS

2.01 MANUFACTURER

A. PRODUCT QUALITY ASSURANCE PROGRAM: Manufacturer shall be an ISO 9001 registered company. A 'Quality Compliance Certificate (QCC) for reporting/confirming the tested values of the SBS-Modified Bitumen Membrane Materials will be supplied upon request.

B. ACCEPTABLE MANUFACTURER:
   1. SOPREMA, located at: 310 Quadral Dr.; Wadsworth, OH 44281; Tel: 800-356-3521; Tel: 330-334-0066; Website: www.soprema.us.
   2. Acceptable Alternate Manufacturers: Hickman Metals

C. Contractor shall furnish all sheet metal flashings, counter flashings, roof edge system, and all other related sheet metal flashings, fasteners, and sealants necessary to flash and counter flash the specified roofing system at all roof terminations, transitions, and penetrations.

D. Sheet metal flashing materials and fasteners shall be compatible with adjacent materials, to accommodate all project related exposures.

E. Pre-Finished (Mill Finished) Sheet Metal Flashing Material: Aluminum, Galvanized Steel, Stainless Steel, Copper.

2.02 SHEET METAL FLASHING

A. SHEET METAL, PARAPET COPING SYSTEM:
   1. SOPREMA SOPRA-TITE Gold Coping Tapered: Engineered parapet coping system with formed anchor clips and metal fascia.
      a. Material: [Aluminum][Galvanized Steel][Stainless Steel]
      b. Gauge/Thickness: [00]
      c. Finish: Kynar 500 Color selected from manufacturer's color chart. Mill-Finished Aluminum.
      d. Tested per ANSI/SPRI ES-1 to meet or exceed design pressures at roof edge.
      e. FM Approved.
   2. SOPREMA SOPRA-TITE Cantilever Coping: Engineered parapet coping system with formed anchor clips and metal fascia.
      a. Material: [Aluminum][Galvanized Steel][Stainless Steel]
      b. Gauge/Thickness: [00]
      c. Finish: Kynar 500 Color selected from manufacturer's color chart. Mill-Finished Aluminum.
      d. Tested per ANSI/SPRI ES-1 to meet or exceed design pressures at roof edge.
      e. FM Approved.
   3. SOPREMA SOPRA-TITE Coping Tapered: Engineered parapet coping system with formed anchor clips and metal fascia.
      a. Material: [Aluminum][Galvanized Steel][Stainless Steel]
      b. Gauge/Thickness: [00]
      c. Finish: Kynar 500 Color selected from manufacturer's color chart. Mill-Finished Aluminum.
      d. Tested per ANSI/SPRI ES-1 to meet or exceed design pressures at roof edge.
      e. FM Approved.
   4. SOPREMA SOPRA-TITE Coping Continuous Cleat: Engineered parapet coping system with formed cleats and metal fascia.
      a. Material: [Aluminum][Galvanized Steel][Stainless Steel]
      b. Gauge/Thickness: [00]

c. Finish: Kynar 500 Color selected from manufacturer's color chart. Mill-Finished Aluminum.
d. Tested per ANSI/SPRI ES-1 to meet or exceed design pressures at roof edge.
e. FM Approved.

B. SHEET METAL, EXPANSION JOINT SYSTEM:
1. SOPREMA SOPRA-TITE Expansion Joint Roof to Roof: Engineered expansion joint system with formed anchor clips and metal cover.
a. Material: [Aluminum][Galvanized Steel][Stainless Steel]
b. Gauge/Thickness: [00]
c. Finish: Kynar 500 Color selected from manufacturer's color chart. Mill-Finished Aluminum.
2. SOPREMA SOPRA-TITE Expansion Joint Roof to Wall: Engineered expansion joint system with formed anchor clips and metal cover.
a. Material: [Aluminum][Galvanized Steel][Stainless Steel]
b. Gauge/Thickness: [00]
c. Finish: Kynar 500 Color selected from manufacturer's color chart. Mill-Finished Aluminum.

C. SHEET METAL, COUNTERFLASHING SYSTEM:
1. SOPREMA 1PC Counterflashing: Engineered counterflashing system with formed counterflashing.
a. Material: [Aluminum][Galvanized Steel][Stainless Steel]
b. Gauge/Thickness: [00]
c. Finish: Kynar 500 Color selected from manufacturer's color chart. Mill-Finished Aluminum.
2. SOPREMA 2PC Counterflashing: Engineered counterflashing system with formed receiver and counterflashing.
a. Receiver: Reglet, Surface-Mount, Adaptable Reglet, Adaptable Surface, Thru-Wall
b. Material: [Aluminum][Galvanized Steel][Stainless Steel]
c. Gauge/Thickness: [00]
d. Finish: Kynar 500 Color selected from manufacturer's color chart. Mill-Finished Aluminum.

D. FASTENERS:
1. #9 Stainless Steel Screw w/ Neoprene Washer
a. Length as required.
2. #12 Galvanized Self-Drilling Screw:
a. Length as required.
3. Stainless Steel Ring Shank Nails:
a. Length as required.
4. 3/16" Tapcon Screws:
a. Length as required.
5. Flat Head Screw w/ Extruded Washer:
a. Length as required.

E. PRIMERS:
1. SOPREMA ELASTOCOL 500 Primer: Asphalt cut-back primer. Primer for the preparation of substrates for hot asphalt, heat-welded and COLPLY and COLPLY MODIFIED ADHESIVE, solvent-based, cold adhesive-applied and cement applications.
a. Meets or exceeds ASTM D41
b. VOC content: 350 g/L or less.

2. SOPREMA ELASTOCOL STICK ZERO Primer: Zero VOC, self-adhesive primer. Low VOC solvent-based primer for the preparation of roof membrane and flashing substrates for self-adhered SBS membrane and self-adhered SBS flashing applications.
3. SOPREMA ELASTOCOL STICK (Formerly ELASTOCOL 600c) Primer: Self-adhered primer. SBS polymer, resin and, solvent-based primer for the preparation of substrates for self-adhered SBS membrane and self-adhered SBS flashing applications.
4. SOPREMA ELASTOCOL 350 (Formerly AQUADERE) Primer: Polymer emulsion primer, meeting low VOC requirements for the preparation of substrates for asphalt, torch and COLPLY and COLPLY MODIFIED ADHESIVE, solvent-based, cold adhesive-applied and cement applications.
5. NOTE: Primer is not required for COLPLY EF Adhesive and COLPLY EF Flashing Cement applications.

F. GENERAL PURPOSE ROOFING CEMENT AND MASTIC:
1. SOPREMA SOPRAMASTIC: SBS Mastic. Fiber-reinforced, roofing cement, packaged in 5-gallon pails. General purpose roofing cement for low-slope roofing used for sealing sheet metal flashings to SBS membranes.
   a. VOC Content: 190 g/L or less.
   b. Meets or exceeds ASTM D4586, Type I, Class II.
2. SOPREMA SOPRAMASTIC: SBS Mastic. Fiber-reinforced, roofing cement, packaged in 10.4 oz caulk tubes. General purpose roofing cement for low-slope roofing used for sealing sheet metal flashings to SBS membranes.
   a. VOC Content: 190 g/L or less.
   b. Meets or exceeds ASTM D4586, Type I, Class II.

G. GENERAL PURPOSE SEALANT:
1. SOPREMA SOPRAMASTIC SP1: General purpose, paintable, gun-grade, elastomeric, polyether moisture curing sealant for sealing SBS and PVC membrane terminations, Kynar 500 PVDF, horizontal and vertical construction joints.
   a. VOC Content: 20 g/L or less.
   b. Meets or exceeds ASTM C920, Type S, Grade NS, Class 50.
   c. [Standard color][custom color]
2. Butyl Sealant: Butyl rubber and polyisobutylene water resistant sealant for concealed sheet metal joints.
3. Butyl Sealant Tape: Butyl rubber and polyisobutylene water resistant sealant tape for concealed sheet metal joints.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examination includes visual observations, qualitative analysis, and quantitative testing measures as necessary to ensure conditions remain satisfactory throughout the project.
B. The contractor shall examine all roofing substrates including, but not limited to insulation materials, roof decks, walls, curbs, rooftop equipment, fixtures, and

wood blocking.

C. The applicator shall not begin installation until conditions have been properly examined and determined to be clean, dry and, otherwise satisfactory to receive specified roofing materials.

D. During the application of specified materials, the applicator shall continue to examine all project conditions to ensure conditions remain satisfactory to complete the specified roofing system.

3.02 PREPARATION

A. Before commencing work each day, the contractor shall prepare all roofing substrates to ensure conditions are satisfactory to proceed with the installation of specified roofing materials. Preparation of substrates includes, but is not limited to, substrate repairs, securement of substrates, eliminating all incompatible materials, and cleaning.

B. Where conditions are found to be unsatisfactory, work shall not begin until conditions are made satisfactory to begin work. Commencing of work shall indicate contractor's acceptance of conditions.

3.03 PRIMER APPLICATION (SBS Modified Bitumen)

A. Examine all substrates, and conduct adhesion peel tests as necessary, to ensure satisfactory adhesion is achieved when adhering membrane to sheet metal flanges.

B. Apply the appropriate specified primer to dry, compatible substrates as required to enhance adhesion of new specified roofing materials.

C. Apply primer using brush or roller at the rate published on the product data sheet.

D. Asphalt Primer: Apply (ELASTOCOL 500 or ELASTOCOL 350) primer to sheet metal flanges before applying asphalt, cold adhesive-applied and heat-welded SBS modified bitumen flashing plies.

E. Self-Adhesive Membrane Primer: Apply (ELASTOCOL STICK or ELASTOCOL STICK ZERO) to sheet metal flanges to enhance adhesion of self-adhesive SBS modified bitumen flashing plies. Ensure self-adhered membrane primer is tacky to-the-touch, but not wet. Primer should not transfer to the fingertips when touched.

F. Do not prime substrates for COLPLY EF Adhesive and COLPLY EF Flashing Cement.

G. Project conditions vary throughout the day. Monitor changing conditions, monitor the drying time of primers, and monitor the adhesion of the membrane plies. Adjust primer and membrane application methods as necessary to achieve the desired results.

3.04 SBS MASTIC AND GENERAL-PURPOSE ROOFING CEMENT APPLICATION

A. Apply SOPREMA SOPRAMASTIC general purpose SBS mastic and roofing cement to seal drain leads, metal flanges and where specified and required in detail drawings.

B. Apply general purpose SBS mastic and elastic roofing cement using caulk gun, or notched trowel at 2.0 – 2.5 gallons per square on each surface. Application rates vary based on substrate porosity and roughness. Tool-in as necessary to seal SBS membrane terminations.

3.05 SHEET METAL FLASHING APPLICATION

A. Refer to manufacturer's sheet metal flashing and roof edge system detail drawings and follow product data sheets and published general requirements for installation instructions.
B. General Requirements:
    1. Follow the most recent edition of the SMACNA Architectural Sheet Metal Manual for fabrication and installation requirements.
    2. Follow the most recent edition of the NRCA Roofing and Waterproofing Manual for fabrication and installation requirements for specified roofing and flashing.
C. Isolate all metal components from ACQ treated wood or other incompatibles material using specified membrane flashing materials.
D. Appliances such as lightning rods, signs, or antennae shall be separate from the roof edge system.

3.06 GENERAL PURPOSE SEALANT

A. Refer to published installation instructions. Ensure sheet metal and adjacent substrates are clean and free of oils, dust, and other incompatible materials.
B. Apply SOPREMA SOPRAMASTIC SP1 general purpose, paintable, gun-grade, elastomeric, polyether moisture curing sealant to seal SBS and PVC membrane terminations, exposed fasteners, Kynar 500 PVDF, and other compatible sheet metal horizontal and vertical joints, laps, and transitions.

3.07 CLEAN-UP

A. Clean-up and properly dispose of waste and debris resulting from these operations each day as required to prevent damages and disruptions to operations.

END OF SECTION

SECTION 07950: SEALANTS AND CAULKING

1. SCOPE

A) The extent of each type of sealant and caulking work is shown on the drawings.

B) The required applications of sealants and caulking include, but are not necessarily limited to, the following general locations:

Flashing reglets and retainers
Exterior wall joints
Masonry control joints, exterior and interior
Flooring joints
Isolation joints, between structure and other elements
Joints at penetrations of walls, decks and floors by piping and other services and equipment
Joints between items of equipment and other construction
Door and windows joints cast stone control joints.

2. GENERAL

A) Compressibility

Specific hardness and compressibility are intended to establish requirements for normal or average conditions of installation and use. Wherever a range of hardness or compressibility is available for a product, comply with the manufacturer's recommendations for the specific condition of use, expect as otherwise directed.

B) Color

Provide each concealed material in manufacturer's standard color which has the best overall performance characteristics for the application shown. Color on exposed materials will be selected by the Architect.

C) Compatibility

Before purchase of the specified sealant, investigate its compatibility with the joint surfaces, joint fillers and other materials behind or below the joint in the construction. Provide only materials (manufacturer's recommended variation of the specified materials) which are known to be fully compatible with the actual installation condition, as shown by manufacturer's published data or certification.

3. MATERIALS

A) Elastomeric Sealants

1. One component polyurethane sealant.

Polyurethane based, one part moisture curing gun grade elastomeric sealant complying with FS TT-S-00230 C,Class A, type 2, ASTM C 920 Type S, Grade NS, Class 25. Product offered by manufacturers complying with these requirements include the following:

Vulken 116, Mameco International
Sikaflex 1A, Sika Corporation

General purpose sealant for use where 25% or less movement is expected at either vertical or horizontal joints. Color to be selected by the Architect.

B) Two component polyurethane sealant.

Polyurethane based, two part high performance elastomeric sealant, complying with FS TT-S-00227E ASTM C-920. Product offered by manufacturers complying with these requirements include the following:

Vulken 922 - Mameco International.
Sikaflex 2C NS/SL, Sika Corporation.

For use where a 50% movement is expected at either vertical or horizontal joints. Color to be selected by the Architect

C) FORMED SEALANTS

1. Compressive Seals: Use PVC specification grade complying with Corps of Engineer and related applicable standards as manufactured by Greenstreak Plastics Products Company or approved equal. Use size and shape specified on plans, where not shown or specified use as follows:

   Expansion Joints: Serrated with centerbulb No. 709
   Construction Joints: Serrated Flat Waterstop No. 781

   Construction Joints at slab on grade or at walls Against grade: Base seal waterstop No. 776

2. Preformed compression seal:

   a. Preformed joint sealers shall be of the types called for in the contract documents and shall conform to the following requirements:
      1. Bituminous type shall conform to ASTM D 994.
      2. Sponge rubber and cork types shall conform to ASTM D 1752.
      3. Non extruding resilient types shall conform to ASTM D 1751.
      4. Elastic fillers of the elastomeric open cell compression type shall conform to AASHTO M 220.
   b. The filler for each joint shall be furnished in a single piece for the full depth and width required unless otherwise authorized by the Architect. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening method satisfactorily to the Architect.
   c. Ems compression seal series AR-200 by Erie Metal Specialties with a design movement capability of 19.05 mm. is to be located as

indicated on plans. Color to be selected by the Architect.

d. Provide premolded expansion joint material of the bituminous type where new construction abutts existing construction of a thickness of 1" or as otherwise indicated on plans.

e. Butyl Rubber Sealant Tape

A partially vulcanized, self-adhesive, non-staining, elastomeric butyl rubber tape recommended by the manufacturer for waterproof construction when compressed 35% in dynamically-moving joints; not less than 98% solids; no deterioration after 3000 hour test in Atlas Weatherometer.

Products offered by manufacturers to comply with the requirements include the following:

Betaseal 650 Tape; Essex Chemical
Duraribbon 1072; PPG Industries
176 Structure glaze; Presstile Interchem
PTI 606; Protective treatments

f. Provide sponge rubber series 1300 of the size indicated on plans and at concrete expansion joints. The product must comply with specifications of ASTM D-1752-type 1, F.S. HH-F-34 If, type II, Class A, AASHTO-M-153-70, type 1. Acceptable manufacturer Williams Products, Michigan.

g. Provide neoprene rubber series 1200 complying with ASTM D-735 grade SC610 and ASTM D-2000 Grade BC610, 60 durometer, 1000 PSI Tensile, at Vibration mounts and at locations where piping and ducts penetrate the structure, Acceptable Manufacturer Williams Products, Michigan.

h. Provide neoprene type NNI series 1040 closed cell expanded neoprene complying with ASTM D-1056 grade RE 41 E 1 and SCE 41 at isolation joints, masonry control joints, joints at expansion or at control joints in cast stone coping. Provide the size indicated on plans and where not indicated the size recommended by the sealant manufacturer for the specific use. Acceptable manufacturer Williams Products, Michigan.

4. MISCELLANEOUS MATERIALS

A) Joint Cleaner

Provide the type of joint cleaning compound recommended by the sealant or caulking compound manufacturer for the joint surfaces to be cleaned.

B) Joint Primer/Sealer

Provide the type of joint primer/sealer recommended by the sealant manufacturer for the joint surfaces to be primed or sealed sealant.

C) Bond Breaker Tape

Polyethylene type or other plastic tape as recommended by the sealant manufacturer to be applied to sealant-contact surfaces where bond to the substrate or joint filler must be avoided for proper performance of sealant. Provide self-adhesive tape wherever applicable, and so recommended by sealant manufacturer.

D) Sealant Backer Rod

Compressible rod stock of polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable non-absorptive material as recommended for compatibility with sealant by the sealant manufacturer; to control the joint depth for sealant

bead on sealant at bottom of joint, to form optimum shape of sealant bead on back side, and to provide a highly compressible backer which will minimize the possibility of sealant extrusion when joint is compressed.

5. JOINT SURFACE PREPARATION

A) Clean joint surfaces immediately befor installation of sealant or caulking compound. Remove dirt, insecure coatings, moisture and other substances which would interface with bond of sealant or caulking compound.

B) For elastomeric sealants, do not proceed with installation of sealant over joint surfaces which have been painted, lacquered, waterproofed or treated with water repellent or other treatment or coating unless a laboratory test for durability (bond-cohesion), in compliance with Paragraph 4, 3, 9, of FS TT-S-00227 has successfully demonstrated that sealant bond is not impaired by the coating or treatment. If laboratory test has not been performed, or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

C) Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's printed instructions indicate that alkalinity does not interface with sealant bond and performance. Etch with 5% solution of muriatic acid; neutralize with diluted ammonia solution, rinse thoroughly with water and allow to dry before sealant installation.

D) Roughen joint surfaces on vitreous coated and similar nonporous materials, wherever sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or wool to produce a dull sheen.

E) The Contractor must examine the joint surfaces, backing, and anchorage of units forming sealant rabbet, and the conditions under which the sealant work is to be performed, and any conditions detrimental to the

proper and timely completion of the work shall be corrected. Do not proceed with the sealant work until unsatisfactory conditions have been corrected in an acceptable manner.

6. SAMPLE INSTALLATION

A) Prepare a mock-up installation of every major type and use of sealant shown and specified. Install sealant between materials matching those used on the project, complying with conditions similar in every wall to anticipated project conditions. Prepare mock-up well in advance of scheduled installation, so that nominal cure-time is allowed and final color adjustments can be made, if necessary.

7. PRE-INSTALLATION MEETING

A) At Contractor's direction, the sealant installer, Architect, sealant manufacturer's technical representative, and other trades involved in coordination with sealant work shall meet with the Contractor at the project site to review the procedures and time schedule proposed for installation of sealants including coordination with other work. Review every major sealant application required on the project.

8. WEATHER CONDITION

A) Do not proceed with installation of liquid sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation. Proceed with the work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength. Whenever joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at extremely low temperatures. Coordinate time schedule with Contractor to avoid delay of project.

9. INSTALLATION

A) Comply with sealant manufacturer's printed instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.

B) Prime or seal the joint surfaces wherever shown or recommended by the sealant manufacturer. Do not allow primer/sealer to spill or migrate into adjoining surfaces.

C) Install sealant backer rod for liquid elastomeric sealants, except where shown to be omitted or specifically recommended by sealants manufacturer to be omitted.

D) Install bond breaker tape wherever shown and wherever required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.

E) Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cave, so that joint will not trap moisture and dirt.

F) For joints sealed with non-elastomeric sealants and caulking compounds, fill joints to a depth in the range of 75% to 125% of joint width.

G) Install sealant to depths following sealant manufacturer recommendation for the specific location on the site.

H) Spillage

1. Do not allow sealants or compounds to overflow or spill into adjoining surfaces, or to migrate into the voids of adjoining surfaces, by either the primer/sealer of the sealant/caulking compound.
2. Remove excess and spillage compounds promptly as the work progresses. Clean the adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage. Do not damage the adjoining surfaces of finishes.

I) Sealant Installation

1. Comply with standards issued by the sealant manufacturer, except where more stringent requirements have been shown or specified.

10. CURE AND PROTECTION

A) Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

B) The Contractor shall take measures to protect the sealants and caulking compounds during the construction period, so that they will be without deterioration or damage (other than normal weathering).

11. TESTS FOR PERFORMANCE

A) After nominal cure of exterior joint sealants which are exposed to the weather, test for water leaks. Flood the joint exposure with water directed from a 3/4" garden hose held perpendicular to wall face, 2'-0" from joint, connected to a water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20ft. per min.

B) Test approximately 5% of total joint system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on

opposite face. Conduct test in the presence of the Architect, who will determine the actual percentage of joints to be tested and the actual period of exposure to water from the hose, based upon the extend of observed leakage, or lack thereof.

C) Repair sealant installation at leaks or, if leakage is excessive, replace sealant installation as directed.

11. TESTS FOR PERFORMANCE

D) Wherever nature of observed leakage indicates the possibility of inadequate joint bond strength, owner may direct that additional testing be performed at a time when joints have been fully cured, followed by natural exposure through both extreme temperatures and returned to the lowest range of temperatures in which it is feasible to conduct testing. Repair or replace work as required.

12. SUBMITTALS

A) Manufacturer's Data, Sealants and Caulking

1. Submit 2 copies of manufacturer's specifications, recommendations and installation instruction for each type of sealant, caulking compound and associated miscellaneous material required. Include manufacturer's published data, or letter of certifications, or certified test laboratory report indicating that each material complies with the requirements and is intended generally for the application shown. Show by transmittal that one copy of each recommendation and installation has been distributed to the Installer.

B) Samples, Sealants and Caulking

1. Submit 3, 12" long samples of each color required by the Architect (except black) for each type of sealant or caulking compound exposed to view. Install sample between 2 strips of material similar to or representative of typical surfaces where sealant or compound will be used, held apart to represent typical joint widths.

C) Guarantee, Sealants

1. Submit 2 copies of written guarantee agreeing to repair or replace sealants which fail to perform as air-tight and water-tight joints; or fail in joint adhesion, cohesion, abrasion, resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified as an inherent quality of the material by submitted manufacture's data. Provide guarantee for a period of 1 year, signed by the Installer and Contractor.

SECTION 08110: METAL DOORS AND FRAMES

1. SCOPE

   A) Include all metal doors and frames, which are not specifically described in other Sections of these Specifications, where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

2. QUALITY ASSURANCE

   A) Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

   B) Provide all products of this Section from a single manufacturer.

3. SUBMITTALS

   A) Product data: Within 45 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
      1. Materials list of items proposed to be provided under this Section;
      2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
      3. Shop Drawings showing details of each frame type, elevations of door designs, details of openings, and details of construction, installation and anchorage.
      4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.

4. PRODUCTS

   A) Metal Doors
      1. Type and design:
         a. Provide full-flush door made of cold rolled galvanized steel, in dimensions and types shown on the drawings, labeled or non-labeled as indicated on the drawings, gauges as specified on drawings, properly reinforced for the finish hardware, and of the manufacturer specified in drawings.

2. Finish:
   a. Pre-clean and shop prime each door for finish painting which will be performed at the job site. Refer to Article 5 of this Section of the specifications.

B) Metal Frames
1. Type and design:
   a. Provide frames made of cold rolled galvanized steel of the types and dimensions shown on the drawings, labeled or non-labeled as indicated in the drawings, gauges as specified on drawings, properly reinforced for the finish hardware and of the manufacturer specified in the drawings.
2. Finish:
   a. Pre-clean and shop prime each frame for finish painting which will be performed at the job site. Refer to Article 5 of this Section of the specifications.

C) Finish Hardware
1. Secure, templates from the finish hardware supplier, and accurately install, or make provision for all, finish hardware at the factory.
2. For concealed overhead door closers, provide the required space, cutouts, reinforcing and provisions for fastening in the top rail of doors or the head of frames, as applicable.
3. Reinforced hollow metal units at the manufacturer's plant to receive surface-applied hardware.

5. SHOP PAINTING

A) Clean, treat and paint all surfaces of fabricated hollow metal units, including galvanized surfaces, whether concealed or exposed in the finished work.

6. DELIVERY

A) Doors and frames shall be properly protected against damage during shipment and handling at job. Deliver all frames and doors when and as directed to designated locations at job site. Store in upright position on wood sills in manner which will prevent rust and injury.

B) Remove mill scale, rust, oil, grease, dirt and other foreign materials before the application of the shop coat of paint.

C) Apply shop coat of baked-on prime paint of even consistency to provide a uniform finished surface ready to receive field-applied paint.

7. SURFACE CONDITIONS

A) Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

8. INSTALLATION

A) Placing frames:
   1. Where practicable, place frames prior to construction of enclosing walls and ceilings.
   2. Set frames accurately into position, plumbed, aligned, and braced securely until permanent anchors are set.
   3. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
   4. In masonry construction, locate 3 wall anchors per jamb at hinge and strike levels. Building-in of anchors and grouting of frames is specified in Section 04220, "Concrete Unit Masonry".
   5. At in place construction, set frames and secure to adjacent construction with machine screws and suitable anchorage devices. Provide "Z" fillers at each screw location.
   6. When installed in prepared openings in concrete construction, provide sealant between frame and concrete.

B) Placing Door
   1. Fit hollow metal doors accurately in their respective frames, within clearances specified in S.D.I. 100.
   2. Install hardware specified in this Division. Adjust hardware to operate and latch or lock securely.

9. ADJUST AND CLEAN

A) Final Adjustments:
   1. Check and readjust operating finish hardware items in hollow metal work just prior to final inspection.
   2. Leave work in complete and proper operating condition.

3. Remove defective work and replace with work complying with the specified requirements.

B) Immediately after erection, sand smooth all rusted and damaged areas of prime coat, and apply touchup of compatible air-drying primer.

10. FIRE RATING

A) When doors are indicated on the drawings as fire rated, such doors and frames shall bear the U.L. Label corresponding to the specific fire rating indicated. When doors are shown as fire rated but with no specific rating indicated, such doors and frames shall bear the U.L. "B" Label.

11. COMPLIANCE

A) The Owner reserves the right to request and pay for an inspection by a representative of the Steel Door Institute to determine that the work of this section has been performed in accordance with the specified requirements.

B) In the even such inspection determines that the work of this Section does not comply with the specified requirements, immediately remove the non-complying items and immediately replace them with items complying with the specified requirements, all at no additional cost to the Owner, and reimburse the Owner for the cost of the inspection.

SECTION 08220: ALUMINUM WINDOWS

1. SCOPE

   A) Furnish all necessary materials, labor and equipment for the complete installation of all aluminum windows as shown on the drawings and specified hereinafter.

2. QUALITY ASSURANCES

   A) Qualifications of Installers:
      1. For actual installation of aluminum windows use only personnel who are thoroughly familiar with manufacturer's recommended methods of installation and who are completely trained in the required skills.

   B) Codes and Standards:
      1. Materials, glass and installation shall comply with "Reglamento de Planificación Enmendado 1987", specifying the minimum wind pressures for given heights.
      2. Windows must meet or exceed the requirements of the Architectural Aluminum Manufacturers Association (AAMA). Test reports certified by an independent test laboratory on similar units must be available upon request. Windows must be tested in accordance with ASTM-E283 for air infiltration tests, ASTM E-331 for water resistant tests, and ASTM E-330 for load tests.

3. SUBMITTALS

   A) For all items submit manufacturer's brochures, specifications, shop installation drawings edited to apply specifically to this project.

   B) Submit samples or sample sections of all specified windows.

   C) Do not install any window until submittals are approved in writing.

4. HANDLING

A) Protection:
   1. Use all means necessary to protect the materials before, during, and after installation and to protect the installed work and materials of all other trades.

B) Replacements:
   1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

5. PRODUCTS

A) Shall be those products specified in the construction drawings.

B) Fasteners:
   1. Clips, bolts, and screws shall be of aluminum, stainless steel or other metallic materials guaranteed by the manufacturer to be non-corrosive and compatible with the aluminum window members, operator, anchors and other components of the window units.

C) Caulking:
   1. Caulk and seal all interior and exterior side openings as specified under Division 7.

6. INSTALLATION

A) Windows:
   1. Windows shall be set level, plum and square in pre-finished openings. Caulk between windows and surroundings construction to provide a weather-tight installation. Adjust all ventilators after glazing to obtain proper operation.

B) Glass and Glazing:
   1. Windows shall be glazed as shown on drawings, and following requirements of "Glazing" section of

Division 8 of these specifications. Ventilators must have all hardware installed and locked securely in place, square and true before glazing. All glazing shall be executed after windows, frames, sash, doors, etc., have been installed. Glass shall be cut accurately and set with equal bearing on entire width of panel. Stops shall be correctly placed, securely fastened.

C) Inspection and Cleaning:

1. Prior to final inspection and acceptance, remove and replace all imperfectly set cracked or broken glass regardless of how or by whom glass is cracked or broken. Remove all dirt, stains, clean and polish all glasses and frames.

7. FINAL ACCEPTANCE

A) For final acceptance of the works specified under this section deliver to the Architect a letter signed by an officer of the firms manufacturing the windows certifying that the materials delivered to the project comply in all respects with the provisions of this section of the specifications and the drawings.

SECTION 08410: ALUMINUM AND GLASS DOORS

1. SCOPE

   A) Furnish all necessary materials, labor and equipment for the complete installation of all glass doors on aluminum frames and specified hereinafter.

2. QUALITY ASSURANCE

   A) Qualification of Installers:
      1. For actual installation of aluminum doors and frames and installation of finish hardware on doors, use only personnel who are thoroughly trained and experienced in the skills required and who are completely familiar with the manufacturer's recommended methods of installation plus the requirement of this work.

   B) Codes and Standards:
      1. Materials, glass and installation shall comply with "Reglamento de Planificación, Enmendado 1987" specifying the minimum wind pressures for given heights.
      2. Items on this section must meet or exceed the requirements of the Architectural Aluminum Manufactures Association (AAMA). Test reports certified by an independent test laboratory on similar units must be available upon request. System must be tested in accordance with ASTM E-283 for air infiltration tests, ASTM E-331 for water resistant tests, and ASTM E-330 for load tests.

3. SUBMITTALS

   A) Material List:
      1. Submit to the Architect a complete list of all materials proposed to be furnished and installed under this Section.

B) Shop Drawings:

1. Accompanying the materials list, submit complete shop drawings showing all details of the fabrication and installation, including proper and adequate provision for installation of the specified glass, and completely describing all hardware.

C) Samples:

1. Accompanying the materials list, submit a sample or section sample of the door illustrating the actual finish obtained in the specified anodizing.

4. HANDLING

A) Protection:

1. Use all means necessary to protect the doors and framing materials before, during and after installation, and to protect the installed work and materials of all other trades.

B) Replacements:

1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

5. PRODUCTS

A) General:

1. All aluminum doors and frames system shall be the product of one manufacturer.

B) Aluminum Door:

1. Furnish all necessary materials, labor and equipment for the complete installation of the aluminum doors and door frames as shown on the drawings and specified herein.
2. Resistance to corner racking shall be tested by the Dual Moment Load test as follows:
   a. Test section shall consist of a standard top door corner assembly. Slide rail section shall be 24" long and top rail section shall be 12" long.

b. Anchor "top rail" positively to test bench so that corner protrudes 3" beyond bench edge.
c. Anchor a lever arm positively to "side rail" at a point 19" from inside edge of "top rail".
d. Test section shall withstand a load of 190 lbs. on the lever arm before reaching the point of failure, which shall be considered a rotation of the lever arm in excess of 45°.

3. Extrusions shall be 6063-T5 alloy and temper. Fastener, where exposed shall be aluminum, stainless steel or plated steel in accordance with ASTM A 164. Perimeter anchors shall be aluminum or steel, providing the steel is properly isoleted from the aluminum. Glazing gaskets shall be EPDM elastomeric extrusions. Major portions of the door stiles shall be .125" in thickness and glazing molding shall be .050" thick.
4. All exposed framing surfaces shall be free of scratches and other serious blemishes.
5. Aluminum moldings shall be given a caustic etch followed by an anodic oxide treatment to obtain a clear anodic coating conforming to Aluminum Association Standard AA-M12 C22 A31, unless otherwise indicated in drawing.
6. Hardware for the entrance door and frame shall be as the follows; unless otherwise indicated on drawings:

a.	Pivots	e.	Push-Pulls
b.	Locks	f.	Thresholds
c.	Door Closer	g.	Weathering System
d.	Exit Device	h.	Exit Device

7. Frames shall be as specified in other Section of this Division.

6. FABRICATION

A) General:
1. Shop prefabricate all doors and frames into complete units, verifying all measurements at the job site prior to fabrication.

7. SURFACE CONDITIONS

A) Inspection:
   1. Prior to installation of the work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation my properly commence.
   2. Verify that the system may be installed in complete accordance with the original design and the approved shop drawings.

B) Discrepancies:
   1. In the event of discrepancy, immediately notify the Architect.
   2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

8. INSTALLATION

A) General:
   1. Install all members with adequate provision for settling, expanding, and contracting to occur without breaking glass.

B) Anchoring:
   1. Firmly anchor all members, using all anchoring devices required to ensure positive attachment of the members for life under hard use.

C) Aluminum Door:
   1. All jambs, head and sill track shall be set in correct locations as shown in the details and shall be level, square, plumb and in alignment with other work in accordance with the manufacturer's installation instructions and approved shop drawings. All joints between framing and the building structure shall be sealed in order to secure a watertight installation. Glass for doors shall meet the requirements of Section 08800 of this Division.

D) Framing System:

1. All door frames shall be set in correct locations as shown in the details and shall be level, square, plumb and in alignment with other work in accordance with the manufacturer's installation instructions and approved shop drawings. All joints between framing and the building structure shall be sealed in order to secure a watertight installation.

E) Caulking:

1. Caulk and seal all interior and exterior sides openings as specified Section 07950 of Division 7.

F) Protection:

1. Wherever aluminum is in contact with steel, concrete, or other material potentially creative of electrolytic action, provide all required permanent isolation of the aluminum by backpainting with first quality bituminous paint or by such other isolation as is approved in advance by the Architect.
2. Protect all finished surfaces as necessary to prevent damage during progress of the work.

9. CLEANING UP

A) General:

1. Immediately prior to acceptance of the work, remove all protective materials from the storefront system and clean all exposed members.

B) Abrasives:

1. Do not use abrasives or harmful cleaning agents.

10. FINAL ACCEPTANCE

A) For final acceptance of the works under this section, deliver to the Architect a letter signed by an officer of the firms manufacturing the systems certifying that the materials delivered to the project comply in all respects with the provisions of this section of the specifications and the drawings.

SECTION 08521: FIXED ALUMINUM WINDOWS

1. SCOPE OF WORK

   A. The work under this section includes all labor and materials for the fabrication and installation of fixed louvers as shown on drawings, as specified herein, and as needed for a complete and proper installation.

2. GENERAL

   A. Standards: Expect as otherwise indicated, the requirements for aluminum windows, and the terminology and standards of performance and fabrication workmanship are those specified and recommended in ANS A134.1, and the applicable general recommendations published by AAMA, NAAMM, AMCA and AA.

   B. Sizes and Profiles: The required sizes for louver units are shown on the drawings. The details shown are based upon standard details by a manufacturer. It is intended that similar details by other manufacturers will be acceptable, provided that it is approved equal by the Architect.

   C. Manufacturer: All items are detailed on the drawings and specified by manufacturer and model number.

3. QUALITY ASSURANCE

   A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. In addition to complying with pertinent regulations of governmental agencies having jurisdiction.
   1. Comply with ANSI A134.1 (AAMA 302.9) for the designations specified;
   2. On each unit, provide an AAMA sponsored label certifying compliance with the specified requirements.

4. SUBMITTALS

A. Product data: Within 35 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
   1. Materials list of items proposed to be provided under this Section;
   2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
   3. Shop Drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades;
   4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basic for accepting or rejecting actual installation procedures used on the Work.

5. MATERIALS

A. Aluminum Extrusions: Extruded shapes shall be made from 6063-T5 aluminum alloy with a minimum wall thickness of .062 inches.

B. Fasteners: Clips, bolts, and screws shall be of aluminum or other metallic materials guaranteed by the manufacturer to be non-corrosive and compatible with the aluminum members.

6. FINISH

A. Aluminum molding shall be given a caustic etch followed by anodic oxide treatment to an Architectural Class 1 anodic coating conforming to Aluminum Association Standard AA-M12-C22-A-31.

7. SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

8. INSTALLATION

A. Install the work of this Section in strict accordance with the manufacturer's recommendations as approved by the Architect, anchoring all units firmly into position square, plumb, straight, and true.

B. Dissimilar materials:
   1. Where aluminum surfaces come in contact with metals other than stainless steel, zinc, or white bronze of small area, isolate the aluminum by one of the following methods.

      a. Paint the dissimilar metal with a prime coat of zinc-chromate primer, followed by two coats of aluminum metal-and-masonry paint.
      b. Paint the dissimilar metal with a coating of heavy-bodied bituminous paint.
      c. Apply a good quality sealant material between the aluminum and the dissimilar metal.
      d. Isolate the dissimilar metals with non-adsorptive tape or gaskets.

C. Set units plumb, level and true to line, without warp or rack of frames or jalousies. Anchor securely in place to masonry at heads and jambs with 1/4' diameter aluminum bolts with stainless steel expansion shields (wood plugs and wood screws will not be accepted). Bolts shall be of sufficient length to penetrate into the concrete a minimum of 1-1/2". Bolts for fastening frames to masonry shall be placed not over 1'-6" center to center. Use not less than two (2) bolts on each side.

D. Set and anchor firmly to concrete or masonry as detailed on the drawings or as approved.

E. Caulk louvers at all intersections with masonry openings and as required by the detail drawings. Caulking shall be forced into the voids or corners in a continuous full bead and tooled to and even surfaces with straight edges. Joints shall be completely watertight.

F. Clean aluminum surfaces promptly after installation of louvers, exercising care to avoid damage to the finish. Remove excess sealant compound, dirt and other substances. Lubricate hardware and other moving parts.

9. CLEANING

A. Labels:
   1. Leave all labels in place, intact and legible, until reviewed and approved by the Architect.
   2. Do not at any time remove required AAMA labels.

B. Prior to completion of the Work, thoroughly clean all exposed surfaces of windows and screens.
   1. Use only the cleaning materials and techniques recommended by the manufacturer of the material being cleaned.
   2. Do not scratch or otherwise damage the glass, screen, or aluminum finish.

SECTION 08540: ALUMINUM CURTAIN WALL SYSTEM

1. SCOPE

A) Work included: Furnish all necessary materials, labor and equipment for the complete installation of all aluminum framing, glazing and glass and sealant for the curtain wall systems as shown on the drawings and specified herein.

2. QUALITY ASSURANCE

A) Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section.

B) Codes and Standards:

1. Materials, glass and installation shall comply with "Reglamento de Planificación Núm. 7 Enmendado 1987", specifying the minimum wind pressures for given heights.
2. Items on this section must meet or exceed the requirements of the Architectural Aluminum Manufactures Association (AAMA). Test reports certified by an independent test laboratory on similar units must be available upon request. System must be tested in accordance with ASTM-E283 for air infiltration tests, ASTM E-331 for water resistant tests, and ASTM E-330 for load tests.
3. The curtain wall system must be designed for the following wind load including the framing system structural support:

HEIGHT (FEET)	**WIND(POUND/SQUARE FEET)**
0-20	47
20-40	51
40-60	61
60-100	66
100-150	75
150-200	80

Due consideration must be given to the increase in the wind loading at the discontinuous edges and corners of the building as required by "Reglamento Número 7".

C) Drawings and specifications are based upon the Series 3200 Curtain Wall System as manufactured by the U.S. Aluminum Corporation. Whenever an equal is to be considered to same must be submitted to the Architect for approval 60 days after given the "Notice to Proceed". Comply with Section 01340 of these specifications.

D) The framing system manufacturer shall be responsible for the design of the framing system and the glass thickness selection. The same must comply with requirements of this section. Also, the manufacturer must design the connections from the Curtain Wall frames to the building structure. The anchoring device must be coordinated with the Contractor. The device must be submitted for approval to the Architect.

3. SUBMITTALS

A) Comply with pertinent provisions of Section 01340.

B) Product data: Within 60 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
1. Materials list of items proposed to be provided under this Section;
2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
3. Shop Drawings showing details of each frame type, elevations of door designs, details of openings, and details of construction, installation and anchorage.
4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.

C) Samples: Accompanying the Shop Drawings, submit:
1. Sample of each exposed member.

2. Samples of finish, showing complete range of color from darkest to lightest proposed for use on this Work. Samples, when approved by the Architect, will be used to verify that finish actually furnished is within the approved range.

D) The Contractor must submit with shop drawings the structural computations of the design of the framing system including its anchoring devices. A Commonwealth of P.R. registered engineer must certify that the system comply with the "Reglamento de Planificación Núm. 7" and the wind load stated in Article 2-B-3 of this Section.

4. PRODUCT HANDLING

A) Comply with pertinent provisin of Section 01640.

5. WARRANTY

A) Upon completion of this portion of the Work, and as a condition of its acceptance, deliver to the Architect two copies of a written Warranty, signed by the subcontractor for this portion of the Work, agreeing to replace work of this Section which fails due to defective materials or workmanship within the following three years after Date of Substantial Completion as that Date is determined in accordance with the General Conditions.

B) Failure due to defective materials or workmanship is deemed to include, but not to be limited to:
1. Failures in operation of operating component or components;
2. Leakage or air infiltration in excess of the specified standard;
3. Deterioration of finish to an extent visible to the unaided eye;
4. Defects which contribute to unsightly appearance, potential safety hazard, or potential untimely failure of the work of this Section or the Work as a whole.

6. PRODUCTS

A) Aluminum Framing:

1. Furnish all necessary materials, labor and equipment for the complete installation of the curtain wall system including its anchoring devices.
2. System shall meet the following requirements:
   a. Air filtration shall be tested in accordance with ASTM E 283. Infiltration shall not exceed .06 CFM per square foot of fixed area when tested at 6.25 P.S.F.
   b. Water infiltration shall be tested in accordance with ASTM E 331. No water penetration at a test pressure of 10 P.S.F.
   c. Structural Performance shall be based on maximum deflection of 1/175 of the span. The system shall perform to this criteria under a wind load of specify in Article 2-B-3.
   d. System shall exceed maximum seismic lateral displacement requirements specified in Section 2312 (h) of the Uniform Building Code, 1985 edition.

3. Extrusion shall be 6063-T5 alloy and temper (ASTM B221 alloy G.S. 10A-T5). Fasteners, where exposed, shall be aluminum, stainless steel or zinc plated steel in accordance with ASTM A 164-71. Perimeter anchors shall be aluminum or steel, providing the steel is properly insulated from the aluminum.
4. Mullion configurations shall allow for pockets at the inside glazing face to receive closed cell neoprene sponge gaskets (ASTM C-509). All mullions and horizontals shall have flexible (PVC) thermal break material located on exterior side of glass plane. Exterior glazing seal gasket shall be fixed resilient elastomeric E.P.D.M. glazing spline secured by extended aluminum pressure plates fastened to main grid members.
5. Provisions shall be made at all sealed horizontals to lead moisture accumulation to exterior.
6. A cover shall be snapped over pressure plate to show only a sharp, uninterrupted exterior profile. Horizontal face covers shall have beveled face on top side.
7. All exposed framing surfaces shall be free of

scratches and other serious blemishes.

8. Aluminum extrusions shall be given a caustic etch followed by an anodic oxide treatment to obtain.
   a. Clear anodic coating conforming to Aluminum Association Standard AA-M12 C222 A31, Number 100 clear.

B) Glazing for the curtain wall system must comply with the requirements of Section 08810 "Glass and Glazing" of this Division, unless otherwise stated on this Section. The glass shall be Sapphire Blue Vari Tran on clear. Provide spandrel glass with same color and at locations indicated in the drawings. The thickness of glass must be determined using the wind loads specified in Article 2-B-3 of this Section and the specified mullion properties and spacings.

C) Caulk and seal all interior and exterior sides of opening as specified in Section 07920 of Division 7.

7. FABRICATION

A) The framing system shall provide for a flush glazing appearance, with no projecting stops. Vertical and horizontal framing members shall have a nominal width of 2 1/4 overall depth of system shall be as indicated in the drawings. System shall provide for two piece horizontal framing so that all fasteners at intersection of horizontal and vertical members will be concealed. There shall be no exposed fasteners at perimeter sections. Horizontal face covers shall be .031 inch less in depth than vertical face covers to prevent exposed edges at intersection of verticals. Horizontal face covers shall have a beveled face on top side of extrusion.

8. SURFACE CONDITIONS

A) Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

9. COORDINATION

A) Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

B) Make measurements as required in the field to assure proper fit.

10. INSTALLATION

A) Install the work of this Section in strict accordance with the original design, the approved Shop Drawings, pertinent requirements of governmental agencies having jurisdiction, and the manufacturer's recommended installation procedures as approved by the Architect, anchoring all components firmly into position for long life.

B) Remove protective coating completely from exposed surfaces as soon as progress of the Work will permit with safety.

C) When glazing is performed under this Section, provide the types of glass required and glaze in accordance with pertinent provisions of Section 08800.

D) All joints between framing and the building structure shall be sealed in order to secure a watertight installation. Comply with Section 07920 of these specifications.

E) Protection:
   1. Wherever aluminum is in contact with steel, concrete, or other material potentially creative of electrolytic action, provide all required permanent isolation of the aluminum by backpainting with first quality bituminous paint or by such other isolation as is approved in advance by the Architect.
   2. Protect all finished surfaces as necessary to prevent damage during progress of the work.

11. CLEANING UP

A) General:
   1. Immediately prior to acceptance of the work, remove all protective materials from the store-front system and clean all exposed members.

B) Abrasives:
   1. Do not use abrasives or harmful cleaning agents.

12. FINAL ACCEPTANCE

A) For final acceptance of the works under this section, deliver to the Architect a letter signed by an officer of the firms manufacturing the systems certifying that the materials delivered to the project comply in all respects with the provisions of this section of the specifications and the drawings.

SECTION 08700: FINISH HARDWARE

1. SCOPE

A) Provide finish hardware throughout the work as specified herein and as needed for a complete and proper installation.

2. DESCRIPTION OF WORK

A) The extent of finish hardware is shown on the drawings and in schedules. Finish hardware is hereby defined to include all items known commercially as builders hardware, as required for swing doors, except special types of hardware specified in the same section as the door and door frame.

3. QUALITY ASSURANCE

A) Manufacturer:
1. To the greatest extent possible, obtain each kind of hardware (latch and lock sets, hinges, closers, etc.) from only one manufacturer.

B) Supplier:
1. Subcontract the furnishing of hardware, only to a recognized builder’s hardware supplier who has been furnishing hardware for a period of not less than two years, and who has in his employment an experienced hardware consultant who is available at all reasonable times during the course of the work, for project hardware consultation to the Architect and Contractor.

C) Installer:
1. Assign the installation of hardware to experienced tradesmen either at the door and frame fabrication plant or at the project site at Contractor's option except as otherwise indicated.

D) Scheduled Designations:
1. Except as otherwise indicated, the use of a manufacturer's numeric designation system in

schedules does not imply that another manufacturer's products will not be acceptable, unless they are not equal in design, size, weight, finish, function, or other quality of significance. However, do not make substitutions after Architect's acceptance of final hardware schedule.

4. SUBMITTALS

A) Manufacturer's Data:

1. Submit two copies of manufacturer's data for each item of finish hardware for approval by Architect. Include whatever information may be necessary to show compliance with requirements, and include instructions for installation and for maintenance of operating parts and exposed finishes.

B) Hardware Schedule:

1. Submit five copies of the final hardware schedule after preliminary schedule is approved in writing by the Architect. Include a separate key schedule, showing clearly how the Architect's final instructions on keying of locks have been fulfilled. Review and acceptance by the Architect does not relieve the Contractor of his exclusive responsibility to fulfill the requirements as shown and specified.

C) Samples:

1. Prior to submittal of the final hardware schedule submit for approval of Architect, one sample of each exposed hardware unit, finished as required and tagged with full description for coordination with the schedule. No hardware shall be ordered, nor shall any work dependent upon approval proceed, until written approval of Architect has been obtained.
2. Samples will be returned to the Contractor. Unit which are acceptable and remain undamaged through submittal, review and field comparison procedures. These samples after final check of operation can be installed by the Contractor on designated doors

by the Architect. Furnish a record of such installation to the Architect.

5. JOB CONDITIONS

A) Coordination:

1. Coordinate hardware with other work. Tag each item of package separately, with identification related to the final hardware schedule, and include basic installation instructions in the package. Furnish hardware items of proper design for use on doors and frames of the thicknesses, profile, swing, security and similar requirements indicated, as necessary for proper installation and function, regardless of omissions or conflicts in the information in the contract documents. Deliver individually packaged hardware items at the times and to the locations (shop or field) for installation, as directed by the Contractor.

B) Templates:

1. Furnish hardware templates to each fabricator of doors, frames and other work to be factory-prepared for the installation of hardware. Upon request, check the shop drawings of such other work, to confirm that adequate provisions will be made for the proper installation of hardware.

6. HARDWARE MATERIALS AND FABRICATION

A) Fasteners:

1. Manufacturer hardware to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.
2. Furnish screws for installation, with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed screws to match the hardware finish or, if exposed in surfaces of other work, to match the finish of such other work as closely as possible, except as

otherwise indicated.

3. Provide concealed fasteners for hardware units which are exposed when the door is closed, except to the extent no standard-manufactured units of the type specified are available with concealed fasteners.
4. Provide fasteners which are compatible with both the unit fastened and the substrate, and which will not cause corrosion or deterioration of hardware, base material or fastener.

7. MARKING, PACKING, DELIVERY AND STORAGE

A) All hardware will be US 26D, dull chromium plated, except as otherwise noted in the schedule. Items not available in US 26D shall be supplied in sprayed aluminum finish.

B) All hardware located at the exhibit area at the upper Plaza will be solid brass.

C) Match the finish of every hardware unit at each door or opening, to the greatest extent possible, and except as otherwise indicated.

D) The Architect will be the sole judge of whether hardware units match the accepted samples and match each other satisfactorily.

E) Provide protective lacquer coating on all exposed hardware finishes of brass, bronze and aluminum, except as otherwise indicated.

8. HARDWARE FINISHES

A) Mount hardware units at heights recommended in "Recommend Locations for Builder's Hardware" by NBHA, except as otherwise specifically indicated or required to comply with governing regulations, and except as may be otherwise directed by the Architect.

9. INSTALLATION

A) Install each hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, install each item completely and then remove and store in a secure place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the substrate.

10. ADJUST AND CLEAN

A) Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Lubricate moving parts with type lubrication recommended by manufacturer (graphite-type if no other recommended). Replace units which cannot be adjusted and lubricated to operate freely and smoothly as intended for the application made.

B) Final Adjustment:
   1. Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make a final check and adjustment of all hardware items in such space or area. Clean and relubricate operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of ventilating equipment.
   2. Instruct Owner's personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

11. KEYING SYSTEM

A) Provide a master keying system. In addition to the permanent system, a construction master keying system shall be incorporated for interim use during

construction. Any pertinent keying requirements not specified herein shall be as directed.

B) Locks and padlocks shall be keyed differently unless otherwise required, and master-keyed (MK) as directed. Three keys shall be provided with each lock or cylinder. Each key shall be stamped with incised figures showing the key change number corresponding with the respective lock or cylinder, and in addition, space shall be provided on each key for the stamping of a code number as prescribed for the keying system.

C) Keys shall have aluminum numbered tags, one for each key, 1-1/16 inches in diameter, attached to key with aluminum chain link or beads. The scheme for numbering keys shall be furnished by the Owner.

SECTION 08800: GLASS AND GLAZING

1. SCOPE

   A) Provide glazing and glazing accessories where shown on the drawings, as specified herein, and as needed for a complete and proper installation.

2. QUALITY ASSURANCE

   A) Qualifications of Installers:
      1. Use adequate numbers of skilled workmen who are thoroughly trained and experience in the skills required, who shall be completely familiar with the referenced standards and the requirements of this work, and who shall personally direct all installation performed under this Section of these specifications.

   B) Codes and Standards:
      1. All materials and installation shall conform to the U.S. Consumer Product Safety Commissions Standard CFR 1201 CI and CII, or for fixed glazed panels as defined in state glazing laws or building code. Also comply with all pertinent recommendations contained in the "Manual of Glazing" of the Flat Glass Marketing Association and with all local codes. Lexgard laminates shall comply with all the requirements of Boca, SBCCI and ICBO for light transmitting Plastic and with all safety/burglary resisting glazing standards of the Consumer Product Safety Commission, 16CFR Part 1201, Category I and Category II, and with ANSI Z97.1 a-1977 and with UL Standard 972.

3. SUBMITTALS

   A) Submit manufacturer's certificates that all materials conform to requirements of the drawings and these specifications.

   B) Submit samples of all types of glass, architectural glazing, glazing compounds and gaskets for approval.

   C) Submit shop drawings for Architect approval prior to execution of work. Do not install any glass or architectural glazing until submittals are approved in writing.

4. PRODUCTS

A) General:

1. All glass shall bear the label of its manufacturer and shall conform in all respects with the pertinent requirements of Federal Specification DD-G-45ld, shall be relatively distortion-free with all distortion shown in the horizontal direction, shall be in the thicknesses, sizes and types shown on the drawings, and shall be the product of the indicated manufacturer.

B) Clear Glass:

1. Clear float glass shall be transparent flat in the q^3 Glazing Quality category and in accordance with the requirements and tolerances of Federal Specifications DD-G-451d, as manufactured by PPG Industries, Inc., One Gateway Center, Pittsburgh, Pennsylvania 15222. Glass to be of the thickness and sizes indicated on drawings.

C) Wire Glass:

1. Wire Glass shall be of the thickness and sizes indicated on drawings, and shall be "Polished Boroque Mississippi Wire Glass" as manufactured by Hordis Brother Inc., 1110 N.W. 159th. Dr., Miami, FL. 33169, (305) 621-3664.

D) Tempered Safety Glass:

1. Tempered safety glass shall be clear, of sizes indicated on drawings, "Herculite" as manufactured by PPG Industries, Inc.

E) Glazing:

1. Glazing at windows shall be polysulfide, silicone butyl rubber and for storefront system shall be extruded vinyl gasket, unless otherwise indicated on drawings, provide some for borrowed lights at interior partitions.

F) Miscellaneous Material:

1. Accessories as required, including points, clips, shims, etc. Metal accessories shall be non-ferrous. Primers and cleaners as recommended by glass manufacturer.

G) Lexan Laminate:

1. Shall be 1/2" Lexgard high security laminate as manufactured by GE Plastics. Supply all miscellaneous materials as required following

manufacturer recommendations for materials and installation. Submit for Architect approval prior to installation sealant, gaskets or tape to be used.

5. HANDLING

A) Use all means necessary to protect glass and glazing materials before, during, and after installation and to protect the installed work and materials of all other trades.

B) In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

6. SURFACE CONDITIONS

A) Inspection:
   1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is completed to the point where this installation may properly commence.
   2. Verify that all glazing may be performed in accordance with all pertinent codes and regulations, the original design, and the referenced standards.

B) Discrepancies:
   1. In the event of discrepancy, immediately notify the Architect.
   2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

7. GLAZING

A) Set all glass and architectural glazing in a true plane, tight and straight, with proper and adequate clearance, firmly anchored to prevent ratting and looseness with all edges cleanly cut; do not nip or seam the edges.

8. CLEANING UP

A) Upon completion of glazing, thoroughly clean all glass surfaces, correct all imperfections, replace all damaged glass and leave all labels on the glass until they have been inspected and approved by the Architect, but remove all labels immediately thereafter.

B) Upon completion of installation of lexan laminate clean all surfaces using only cleaning solutions approved in writing by manufacturer and following manufacturer instructions. Leave all labels until they have been inspected and approved.

9. FINAL ACCEPTANCE

A) For final acceptance of the works specified under this section deliver to the Architect a letter signed by an officer of the firms manufacturing the glass and the architectural glazing certifying that the materials delivered to the project comply in all respects with the provisions of this section of the specifications and drawings.

SECTION 09220: CEMENT PLASTER

1. SCOPE

   A) Includes all cement plaster as shown on the drawings and specified herein.

2. QUALITY ASSURANCES

   A) Qualifications of Plasterer:
      1. For the cement plaster, use only skilled journeyman plasterers who are completely familiar with the requirements of the work.
      2. In acceptance or rejection the cement plaster no allowance will be made for the lack of skill on the part of the plasterers.

3. GENERAL

   A) Delivery and Storage of Materials: Except for sand and water, deliver materials to the site in sealed containers or bags fully identified with manufacturer's name, brand, type and grade. Store materials in a dry, well-ventilated space, under cover, off the ground and away from surfaces subject to dampness or condensation.

   B) Warm Weather Requirements: Protect plaster against uneven and excessive evaporation and from strong blasts of dry air, both natural or artificial. Apply and cure plaster as required by climatic and job conditions to prevent rapid dry out. Provide suitable coverings, moist curing, barriers to deflect sunlight and wind, or combinations of these, as required.

   C) Ventilation Requirements: Provide natural or mechanical means of ventilation to properly dry interior plaster during and after application.

   D) Sample Installation: Prior to installation of plaster work, plaster sample section of each type of plaster required for approval of the Architect. Demonstrate the proposed range of texture, workmanship, and color if required, to be expected in the complete work.

4. MATERIALS

A) Bonding Compound: ASTM C 631 of FS MMM-B 350 or MIL Spec. 19235. For exterior use, provide bonding compound which is not affected by moisture on surface or present in plaster base and suitable for temperature conditions at application time.

B) Aggregate: Natural or manufactured sand, complying with ASTM C 144, except graded within the following limits (expressed as the minimum and maximum percentage retained by weight on U.S. Standard Sieves, plus or minus 2%); No. 4 Sieve - 0%, No. 8 Sieve - 0 to 16%, No. 15 Sieve - 10 to 40%, No. 30 Sieve - 30 to 65%, No. 50 Sieve -95 to 100%.

C) Portland Cement: ASTM C 150, Type I color gray unless otherwise called for by the finish schedule.

5. INSTALLATION

A) General Requirements: Mix materials for a minimum of 2 minutes or until all ingredients present a uniform color in the mixer. Use the minimum amount of water required to produce plaster of a workable consistency. Use only clean water, free from impurities which might impair the plaster work.

1. Hand apply plaster to the specified thickness. Machine application of plaster will not be allowed, except where sprayed-on plaster is specified.
2. Apply plaster to an entire wall or ceiling panel with interruptions occurring only at junctions of plaster planes or at openings or expansion and control joints (if any). Where the distance between such natural interruptions exceeds 20' in either direction, plaster application may be interrupted when the practical application limits is exceeded.
3. Where plaster abuts frames or other items of metal or wood which act as plaster ground, and plaster is not terminated by a casing bead, tool edge of plaster to produce a small uniform "V" joint.

4. Wherever a masonry abuts or adjoins the concrete frame-work, tool plaster to produce a "V" joint.
5. Apply second basecoat with sufficient material and pressure to ensure tight contact with first basecoat. Bring surface to a true, even plane rodding and float to a uniformly rough surface. Fill defects and scratches with plaster.
6. After the second coat has been allowed to dry slowly for 24 hours, the finish coat shall be applied to a thickness of not less than 1/8" thick, with a sand float finish.
7. Plaster work shall be finished level, plumb, square, and true, within a tolerance of 1/8-inch in 10 feet, without waves, cracks, blisters, pits, crazing, discolorations, or other imperfections. Plaster work shall be formed carefully around angles and contours, and well up to screeds. Special care shall be taken to prevent sagging. There shall be no visible junction marks in finish coat where one day's work adjoins another. Finished work shall be covered and protected in an approved manner to prevent damage.

B) Plaster Proportions: (By Volume)

Sand	5 3/4parts
Lime	1 part
Cement	1 1/3 parts

1. Hair or fiber may be used in the mix for the first (scratch) basecoat applied to metal lath. Do not use more than one pound of hair or fiber per bag of cementations material. Use goat, cattle or deer hair or pure minilla fiber, 1/2" to 2" long, free from grease, oil, dirt and other impurities.
2. Accurately measure ingredients, including water, using measuring devices of known volume. Do not use shovel or water buckets as measuring devices. Proportion successive batches alike.
3. Place coat within a maximum of 2-1/2 hours after mixing, except during hot, dry weather, reduce maximum placing time as required to prevent premature stiffening of plaster.

C) Plaster over Metal Latch: Apply 3 - coat plaster over all metal lath, with or without solid backing. Apply first (scratch) coat not less than 1/2" thick and second (brown) basecoat not less than 1/4" thick.

1. Measure thickness of plaster from back plane of metal lath (exclusive of ribs of dimples), except if metal lath is applied over solid base, measure from face of solid baking.
2. Apply first basecoat with sufficient material and pressure to form full keys through metal lath and to embed lath with sufficient plaster coverage. After first coat is firm, scratch (score) in one direction only, to provide mechanical bond for second coat. On vertical surfaces, scratch in horizontal direction.

D) Plaster Over Concrete or Masonry: Surface shall be free of loose or deteriorated areas, clean and free of dust, loose particles, and foreign matter.

1. Apply bonding agent to concrete surfaces prior to application of plaster, in accordance with manufacturer's instruction.
2. Apply plaster in a single coat not less than 3/8" thick, rod to a true, smooth surface and float to an even sand finish.

E) Moisture Retention Requirements: Dampen bases, if required, for proper suction. Do not saturate bases and do not apply plaster until visible surfaces water disappears.

1. Dampen previous plaster coats which have dried out prior to time for applications of next coat. Dampen with water as required for uniform suction.
2. The Contractor is responsible for determining the most effective procedure for curing and time lapse between application of coats based on climatic and job conditions. Plaster which is cracked or crazed due to improper timing and curing will not be accepted. Remove and replace unacceptable plaster including plaster base materials, if damaged during removal of defective plaster.

6. CUTTING AND PATCHING

A) Cut, patch, repair, and point-up plaster as required and as directed by the Architect. Repair cracks and indented surfaces by moistening plaster and filling with new material, troweled or tamped flush with adjoining surfaces. Pint-up finish plaster surfaces around items which are built into or penetrate plaster surfaces.

7. CLEANING AND PROTECTION

A) Make provisions to minimize spattering of plaster on other work. Promptly remove plaster from door frames, windows and other surfaces which are not to be plastered. Repair floors, walls and other surfaces which have been stained, marred or otherwise damaged during the plastering work. When plastering work is completed, remove unused materials, containers and equipment and clean floors of all plaster debris.

B) Contractor shall be aware of requirements for protection of plaster from deterioration and damage until time of acceptance of the work.

(SERVER ADMIN.-0618-ESP.-09-220)

SECTION 09260: GYPSUM WALLBOARD SYSTEM

1. SCOPE

A) The Contractor shall furnish all materials, labor and scaffolding to complete satisfactorily all gypsum (drywall) wallboard work shown and detailed on the drawings.

2. SYSTEM

A) The gypsum wallboard system shall compromise floor and ceiling tracks and screw stubs fabricated from hot dip galvanized steel, and gypsum wallboards which are attached with self-drilling drywall screws. All materials shall be supplied by a single source.

3. MATERIALS

A) Manufacturer
   1. System shall us specified in the Finishes Schedule.

B) Components
   1. For partitions:
      a. Panel-5/8" Thick Sheetrock Brand Firecode Wallboard
      b. Screw Stud-2 1/2", Gage 25, Galvanized Steel
      c. Screw Stud Track-2 1/2", Gage 25 Galv. Steel
      d. Drywall Screws Type "S"-1 1/4" length
      e. Drywall Screws Type "S" Pan Head- 3/8"
   2. For Ceiling:
      a. Panel 5/8" Thick Sheetrock Brand Firecode Wallboard (See Article 10)
      b. Furring Channel- 2 1/2", Gage 25, Galvanized Steel Screw Stud
      c. CR Channel - 1 1/2"
      d. Tie Wire-#12 Gauge Pre-stressed Galvanized Steel Hanger Wire
      e. Screws-Type "S" Self Drilling Drywall Screws

C) Joint Treatment Materials
   a. Joint Tape
   b. Ready Mixed Joint Compound

D) Accessories
   1. Galvanized 1 inch x 1 inch corner beads
   2. Galvanized steel casing beads and trim
   3. E-Z strip expansion joint

4. INSTALATION

A) General
   1. Preparation for work
      a. Examine and inspect materials to which gypsum board is to be applied. Remedy all defects prior to installation due to misaligned framing or other causes that will be responsibility of the work performed under that section of the specification.
      b. Maintain an uniform room temperature between 55° F and 70° F in cold weather during application of wallboard, joint treatment, texture and decoration, and until completely dry or occupied. Provide adequate ventilation.
   2. Cutting Wallboard
      a. Gypsum wallboards shall be cut by scoring and breaking, or by sawing, workings from the face side. Where board meets projecting surfaces, it shall be scribed neatly.
   3. Caulking
      a. For sound rated partitions, acoustical sealant is recommended to prevent sound leaks in areas not adequately sealed by normal construction methods. Sealant material must be non-hardening, non-staining and easily applied with a caulking gun.
      b. Beads should be 1/4" diameter minimum but bead must be increased in size as necessary to assure positive seal. Sealant is recommended at the following locations:
         1. Serpentine bead under floor track or sole plate in all cases. (A single, straight bead under center of track is acceptable if positive sea is accomplished).

2. A similar bead under ceiling or wall track if junction is not otherwise sealed. (When wall or ceiling junction is taped, caulking is not required).

c. Where partition is finished with a casing bead at junction of ceiling or wall, use 500 VG casing bead or a bead of caulking located so the inner edge of casing bead compresses the caulking.

d. A similar bead at floor line after finish layer of wallboard is applied and before installation of base.

4. Installing Wallboard

a. Gypsum wallboard shall be applied first to ceiling at right angles to framing members, then to walls, boards of maximum practical length shall be used so that an absolute minimum number of end joints occur. Board shall be brought into contact with each other but shall not be forced into place.

b. Wallboard joints at openings shall be located so that no end joint will align with edges of opening unless control joints will be installed at these points. End joints shall be staggered, and joints on opposite sides of a partition shall not occur on the same stud.

c. Gypsum wallboard shall be held in firm contact with the framing member while fasteners are being driven. Fastening shall proceed from center portion of the wallboard toward the edges and ends. Fasteners shall be set with the heads slightly below the surface of the wallboard in a dimple formed by the hammer or power screwdriver. Care shall be taken to avoid breaking the face paper of the wallboard. Improperly driven nails or screws shall be removed.

B) Partition and Fascia

1. Align floor and ceiling tracks to assure plumb partition. Secure track with suitable fasteners at a maximum of 24" o.c. Position studs in track on 24" centers by rotating into place for a friction fit. Secure studs located adjacent to door and window

frames, partition intersections and corners by 3/8" pan head Type "S" screws through both flanges of studs and tracks.

2. Single Layer or First Ply
   a. Apply gypsum wallboard with the length parallel to the studs. Center abutting ends or edges over the stud flanges.
   b. Locate all attaching screws 12" o.c. Attach the gypsum wallboard to Screw Studs with Type "S" Drywall Screws using an electric, Drywall Screwdriver with a #2 Phillips bit. For vertical wallboard application with studs 2' o.c., erect the wallboard on one side of the partition, screwing it to the studs at vertical wallboard joints. The first row of screws to be driven at a wallboard joint should be in the face of the stud adjacent to the stud web.
   c. Complete the wallboard application to the entire side of the partition in this manner. For the opposite side, cut the first wallboard panel 2 ft. wide so that joints will be staggered. Fasten this and succeeding wallboard panels to all studs on this side. When partition face is completed, return to the first side and complete screw attachment of wallboard to all studs.
   d. Make door and window framing opening of such size that when the wallboard is secured to the studs, it will fit snugly into the steel frames.
3. Door Frames
   a. As specified in drawings

C) Ceilings
1. Direct attachment
   a. Attach furring channels (Screw Studs) at a maximum span of 5'-0" and spaced not more than 24 inches center to center. Wire tie furring channels to steel bar joint or attach with fasteners to concrete slab.
   b. Apply wallboard with its long dimension at right angles to the channels. Locate wallboard butt joints over the center of the

furring channels. Attach wallboard with 1" self-drilling drywall screws 12" o.c. located not less than 3/8" from edges.

2. Suspended
   a. Attach furring channels spaced not more than 24" o.c. perpendicular to 1-1/2" C.R. Channels with #12 gauge pre-stressed wire at a maximum of 4'-0" c.c.
   b. Apply wallboard with its long dimension at right angles to the furring channels. Locate wallboard butt joints over the center of furring channels. Attach wallboard with 1" self-drilling drywall screws 12" o.c. in the field of the board; 12" o.c. at butt joints, located not less than 3/8" from edges.

5. JOINT AND CORNER FINISHING

A) A uniformly thin layer of Joint Compound shall be applied over the joint approximately 4" wide. The tape shall be centered over the joint and embedded into the compound leaving sufficient Joint Compound under the tape to provide proper bond. Ceiling and wall angles and inside corner angles shall be reinforced with the tape folded to conform to the angle and embedded into the compound.

B) After compound is thoroughly dry, approximately 24 hrs. for regular compound, the tape shall be covered with a coat of Joint Compound spread over the tape approximately 3" on each side of the tape, and feathered out at the edge. After thoroughly dry, another coat of Joint Compound shall be applied with a slight, uniform crown over the joint. This coat shall be smooth and the edges feathered approximately 3" beyond the preceding coat.

C) All inside corners shall be coated with at least one coat of Joint Compound with the edges feathered out.

D) All nail or screw head dimples shall receive three coats. This may be applied as each coat is applied to the joints.

E) Flanges of wallboard corner bead shall be concealed by at least two coats of Joint Compound. The second coat shall be feathered out approximately 9" on both sides of the exposed metal nose.

F) Allow each application of compound to joints and fastener heads to dry, then sand if necessary. Caution shall be used to avoid roughing of the wallboard paper. All wallboard and treated areas shall be smooth and ready for decoration.

G) All openings cut in slabs for plumbing and electrical utilities must be filled with gypsum grout, mineral wool or other approved materials and/or systems to prevent the passage of heated air and smoke to maintain fire resistant integrity.

H) Provide all necessary materials and accessories to protect the light fixture, and air ducts and diffusers such as to met the specified fire rated resistance.

7. COMPLIANCE

A) Gypsum wallboard system must comply with a fire resistance rating of 1 hour minimum as established by the NFPA 251, Standard Methods of Fire Tests of Building Construction and Materials.

B) Contractor must verify that the installed system will meet the specified fire resistance rating. If this is not the case notify the Architect immediately.

8. FINAL ACCEPTANCE

A) For final acceptance of the works specified under this section deliver to the Architect a letter signed by the Contractor certifying that the gypsum wallboard system comply in all respects with the provisions of this section of the specifications and drawings, and will meet the established fire resistance rating.

9. SURFACE FINISH

A) As per specified on the drawings and following requirements on this DIVISION.

10. MOISTURE RESISTANT BOARD

A) In exterior ceilings (and areas of no air conditioning) the panels shall be 5/8" thick Sheetrock Brand Water Resistant Firecode Type X Gypsum Panels by U.S.G.

(SERVER-ADMIN-0618-ESPECIFICACIONES-09260)

1. SCOPE

   A) Provide ceramic tile where shown on the drawings, as specified in the drawings and herein, and as needed for a complete and proper installation.

2. QUALITY ASSURANCE

   A) Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

   B) Provide manufacturer's Master Grade Certificate stating type and location of each tile material in this section.

   C) Provide materials obtained from only one source for each type of tile and color to minimize variations in appearance and quality.

3. SUBMITTALS

   A) Product data: Within 45 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
      1. Materials list of items proposed to be provided under this section.
      2. Manufacturers' specifications and other data needed to prove compliance with the specified requirements.
      3. Samples of each type, class, and color of ceramic tile required, not less than 12" square, mounted on plywood or hardboard backing, and grouted as specified.

   B) Except when specifically exempted by the Architect, submit Master Grade Certificates for each shipment of ceramic tile prior to arrival of the job site.

4. HANDLING

   A) Delivery and Storage

      1. Deliver all materials of this section to the job site in their original unopened containers with all lables intact and legible at time of use.
      2. Store all material under cover in a manner to prevent damage and contamination; store only the specified materials at the job site.

B) Protection
1. Use all means necessary to protect tile materials before, during and after installation and to protect the installed work and materials of all other trades.

C) Replacement
1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

5. PRODUCTS

A) Ceramic Tiles
1. Provide ceramic tile and accessories complying with Tile Council of America Specification 137.1, in colors and patterns selected by the Architect from standard colors and patterns of the approved manufacturers.
2. Floor tile shall have a coefficient of friction not less than 0.50 when tested in accordance with ASTM F489, ASTM F609, and the National Bureau of Standards Technical Note 895.
3. For base, counterstops, and wall surfaces, provide ceramic specified in the drawings.

B) Provide standard accessory shapes as follows:
1. Wall = In corner square and bullnose cap of wainscoat,
2. Floors = Cove base,
3. Curbs = Bullnose and cove,
4. Jambs = Bullnose.

C) Setting Materials
1. Comply with pertinent recommendations contained in the Tile Council of America "Handbook for Ceramic Tile Installation".
2. Provide setting material as specified in the drawings and meeting the following requirements:
a. Portland cement mortar:
1. Materials:
a. Portland cement complying with ASTM C150, type I or II.
b. Sand complying with ASTM C144.
c. Building paper complying with Fed Spec UU-B-790.
d. Galvanized steel diamond mesh weighing 3.4 lbs. per sq. yd.
e. Hydrated lime complying with ASTM C206.
f. Clean potable water.
g. Paper-backed metal lath complying with Fed Spec QQ-L-101 may be used in lieu of the combined mesh and building paper called for above.

2. Where used on floors, provide a job-mix of one part portland cement to six parts sand.
3. Where used on walls, provide a job-mix of one part portland cement to five parts sand, with 1/2 part lime, except where other proportions are approved in advance by the Architect.

b. Dry set mortar:
1. Provide a commercially prepared mixture of portland cement, sand, and additives imparting water-retentivity, for use as a bond coat for setting tile.
2. Comply with ANSI A118.1; except where specifically indicated on the drawings or directed in advance by the Architect, provide conductive dry-set mortar complying with ANSI A118.2.

c. Latex-portland cement mortar:
1. Provide a commercially prepared mixture of portland cement and special latex additive for use as a bond coat for setting tile.
2. Comply with ANSI A118.4.

d. Epoxy mortar:
1. Provide a commercially prepared mortar system employing epoxy resin and epoxy hardener portions.
2. Comply with ANSI A118.3.

e. Modified epoxy emulsion mortar:
1. Provide a commercially prepared mortar system employing emulsified epoxy resins and hardeners with portland cement and silica sand.
2. Secure the Architect's specific approval of the proposed material prior to use.

f. Furan mortar:
1. Provide a commercially prepared mortar system consisting of furan resin and furan hardener portions.
2. Secure the Architect's specific approval of the proposed material prior to use.

g. Epoxy adhesive:
1. Provide an adhesive system employing epoxy resin and epoxy hardener portions formulated for thin-setting of tile on floors, walls and counters with epoxy as the major binder.
2. Provide a product licensed by the Tile Council of America, and bearing that license symbol.

h. Organic adhesive:
1. Provide a prepared organic material, ready to use with no further addition of liquid or powder, which cures or sets by

evaporation.

2. Comply with ANSI A136.1, using type I where exposed to prolonged water presence and using type II at all other locations.

i. Special tile setting mortars will be considered by the Architect when complete technical data is submitted in advance.

D) Grout

1. Comply with pertinent recommendations contained in the Tile Council of America "Handbook for Ceramic Tile Installation" in colors selected by the Architect from standard colors available from the approved manufacturers.
2. Provide grout as specified drawings and meeting the following requirements:
   a. Sand-portland cement grout:
      1. Materials:
         a. Portland cement complying with ASTM C150, type I or II.
         b. Sand complying with ASTM C144.
         c. Hydrated lime complying with ASTM C206.
         d. Clean potable.

      2. Where this grout is indicated on the drawings, or is otherwise directed or required, provide a job-mix consisting of:
         a. For joints less than 1/8" wide: One part cement to one part fine graded sand;
         b. For joints 1/8" to 1/2" wide: One part cement to two parts fine graded sand;
         c. For joints wider than 2": One part cement to three parts fine graded sand;
         d. Up to 1/5 part lime may be added.
   b. Commercial portland cement grout:
      1. Provide a commercially prepared mixture of portland cement and other ingredients producing a water-resistant, dense, uniformly colored material.
      2. Secure the Architect's specific approval of the proposed material prior to use.
   c. Dry-set grout:
      1. Provide a commercially prepared mixture of portland cement and additives producing water-retentivity, and suit - able for grouting all walls and floors subject to ordinary use.
      2. Provide a product licensed by the Tile Council of America, and bearing that license symbol.

d. Latex-portland cement grout:
   1. Provide a commercially prepared mixture.
   2. Secure the Architect's specific approval of the proposed material prior to use.

e. Mastic grout:
   1. Provide a commercially prepared grouting composition designed to be used directly from the container, not requiring damp curing, and with high flexibility and stain resistance.

f. Furan resin grout:
   1. Provide a commercially prepared grout system consisting of furan resin and hardener portions, specifically formulated for chemical resistance.
   2. Secure the Architect's specific approval of the proposed product prior to use.

g. Epoxy grout:
   1. Provide a grout system employing epoxy resin and hardener portions, with coarse silica filler permitted, especially formulated for industrial and commercial use where chemical resistance is of paramount importance.
   2. Provide a product licensed by the Tile Council of America, and bearing that license symbol.

h. Silicone rubber grout:
   1. Provide an engineered elastomeric grout system for interior use employing a single component non-slumping silicone rubber which, upon curing, is resistant to staining, moisture, mildew, cracking, crazing, and shrinking.

2. Secure the Architect's specific approval of the proposed product prior to use.

E) Other Materials
   1. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

6. SURFACE

A) Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

7. INSTALLATION

A) General:
   1. Comply with ANSI A108.1, ANSI A108.2, and the

"Handbook for Ceramic Tile Installation" of the Tile Council of America, except as otherwise directed by the Architect or specified herein.
2. Maintain minimum temperature limits and installation practices recommended by materials manufactures.
3. Do not install tile floors over membrane until the membrane has been tested and accepted.

B) Except where otherwise indicated on the drawings or directed by the Architect, provide portland cement setting beds for walls and floors.

C) Limits of tile:
1. Extend tile into recesses and under equipment and fixtures to form a complete covering without interruptions.
2. Terminate tile neatly at obstruction, edges, and corners, without disruption of pattern or joint alignment.

D) Joining pattern:
1. Lay tile in grid pattern unless otherwise indicated on the drawings or directed by the Architect.
2. Align joints when adjoining tiles on floor, base, trim, and walls are the same size.
3. Layout tile work, and center the tile fields both directions in each space or on each wall area.
4. Adjust to minimize tile cutting.
5. Provide uniform joint widths

E) Provide expansion and control joints where shown on the drawings, and where otherwise recommended by the "Handbook for Ceramic Tile Installation" of the Tile Council of America.

F) Grouting:
1. Follow grout manufacturer's recommendations as to grouting procedures and precautions.

G) Cleaning:
1. Upon completion of placing and grouting, clean the work of this section in accordance with recommendations of the manufacturers of the materials used.
2. Protect metal surfaces, cast iron, and vitreous items from effects of acid cleaning.
3. Flush surfaces with clean water before and after cleaning.

H) Provide tile surfaces clean and free from cracked, broken, chipped, unbonded, and otherwise defective units.

9. PROTECTION AND CLEANING

A) Protection:
   1. Apply to all clean, complete tile walls and floors a protective coat of neutral cleaner solution, 1 part cleaner to 1 part water.
   2. In addition, cover all tile work with heavy duty, non-staining construction paper, masket in placed.

B) Cleaning:
   1. It shall be the Contractor's sole responsibility to properly protect all tile work from damage or defacement of whatever nature until final inspection and acceptance of the work.
   2. Just prior to final inspection and acceptance remove all protective coverings and wash and clean tile to the satisfaction of the Architect.

10. COMPLIANCE

A) The Contractor must verify that the specified material will meet the requirements of Class I Interior Floor Finish as specified in the National Fire Protection Association's Life Safety Code, latest edition (NFPA 10C). If the specified material does not meet this requirement notify the Architect immediately.

11. FINAL ACCEPTANCE

A) For final acceptance of the works specified under this section deliver to the Architect a letter signed by an officer of the firms manufacturing the tiles certifying that the materials delivered to the project comply in all respects with the provisions of this section of the Specifications and Drawings. Also the Contractor must certified that the materials have been installed following manufacturer's recommendations and will meet the specified floor finish requirements.

(SERVER-ADMIN-0618-ESPECIFICACIONES-09-310)

SECTION 09510: ACOUSTICAL HUNG CEILING

1. SCOPE

A) Provide acoustical fire rated ceilings where shown on the drawings, as specified in the drawings and herein, and as needed for a complete and proper installation.

2. QUALITY ASSURANCE

A) Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

3. SUBMITTALS

A) Product data: Within 45 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
   1. Materials list of items proposed to be provided under this section;
   2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
   3. Shop drawings in sufficient detail to show suspension layout, lateral restraint, installation, anchorange, and interface of the work of this section with the work of adjacent trades;
   4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used for the work.
   5. Submit for approval of ARCHITECT/ENGINEER three samples of the following products:
      a. Exposed Grids: 12" long samples of main runners and cross tees.
      b. Moldings: 12" long samples.
      c. Acoustical Lay-in Panels: Submit 3 sets of 12" square samples for each different panel required.

4. PRODUCTS

A) Delivery of materials: Deliver materials in original unopened packages, clearly labeled with manufacturer's name. Item description, specification number, type and class, as applicable.

B) Inspection: Promptly inspect delivered materials; file freight claims for damage during shipment and order replacement material, as required. Do not install damaged or

obviously faulty components.

C) Storage: Store in manner that will prevent warpage, scratches, or damage of any kind. Prevent interference to/by other trades and any other adverse job conditions due to storage locations or methods.

D) Handling: Handle in such manner to insure against racking, distortion or physical damage of any kind.

5. EXTRA STOCK

A) Deliver to the Owner for his use in future modifications, an extra stock of approximately 10% of each type of acoustical material installed, packaging each type of material separately, distinctly marked, and adequately protected against deterioration.

6. PRODUCTS

A) Grid Suspension System

1. Provide a complete fire rated system of supporting members, anchors, wall cornices, adapters for light fixtures and grilles, and accessories of every type required for a complete suspended "T" grid sysem of the arrangements shown on the drawings, in color or colors selected by the Architect from standard colors of the approved manufacturer, and complying with pertinent requirements of Underwriters Laboratories, Inc., and the governmental agencies having jurisdiction.
2. Materials shall comply wih ASTM C-635, heavy duty classification, commercial quality cold-rolled steel; exposed surface prefinished.
3. System will consist of main tees and cross tees, built to lock together to form the modules shown on the drawings for installation of the specified acoustical panels.
4. Suspension system components shall be designed to support the ceiling assembly indicated on project drawings with maximum deflection of 1/360 of the span, including appropriate load-carrying capacity for acoustical panels, light fixtures, and HVAC elements.
5. The fire rated grid system shall be composed of 1 1/2 inch high by 12 foot main tees with single controlled expansion relief combined with 1 inch high or 1 1/2 inch high fire rated cross tees. Components connected with plug-in positive lock insertion. Pull-out tension values in excess of 300 lb. All components of the system shall be listed and labeled by the Underwriter's Laboratories, Inc. (U.L.).

6. Shadow moulding shall be provided on perimeter of acousting ceiling. Moulding shall be formed from commercial quality cold-rolled steel electro galvanized coated with pre-painted flanges. Flanges will be 3/4" x 1/2" revel.
7. Wire hangers shall be #12 gauge pre-stressed galvanized steel hanger wire at a maximum spacing of 4'-0" o.c. or as required by the U.L. fire resistance directory.

B) Acoustical Ceiling Panels
1. Acoustical material shall be of the type and pattern specified in the drawings, and according to Federal Specification SS-S-118. Panel size shall be 5/8 inch or larger with an edge detail as specified in drawings.
2. Acoustical materials shall have a washable matte white finish with a light reflectance LR-1 according to Federal Specification SS-S-118 unless otherwise indicated.
3. Acoustical materials shall have Noise-Reduction Coefficient (NRC) in range 60-70 according to ASTM C 423, "Sound Absorption of Acoustical Materials in Reverberation Rooms".
4. Ceiling Sound-Transmission Class (STC) shall be in the range 30-34 according to AMA 1-11 Ceiling Sound-Transmission Test by Two-Room Method.
5. Acoustical material shall have a Class A Flame-Spread Index according to Federal Specification SS-S-118.
6. Panels shall be fire rated, and listed and labeled by the U.L.

7. FIRE PROTECTION

A) Acoustical ceiling installation shall be fire-rated composed of fire-rated suspension system and fire-rated acoustical panels.

B) The fire resistive ceiling assembly shall be listed and labeled under U.L. to provide one-hour fire rated protection.

8. SURFACE CONDITION

A) Environmental requirements:
1. Building conditions: Building shall be enclosed with all windows and exterior doors in place and glazed, and roof watertight before installation of suspension system.
2. Interior temperatures in building: Climatic conditions in areas to receive ceiling suspension

systems shall range from 60° F(15.56° C) to 85° F(29.44° C) and relative humidity of not more than 70 percent shall be maintained before installation of components.

B) Coordination will other work:
   1. General: Coordinate with other work supported by or penetrating through ceiling, including mechanical and electrical work and partition systems.
   2. Mechanical work: Ductwork above suspension system shall be complete and permanent heating installation of suspension systems.
   3. Electrical work: Installation of conduit above suspension system shall be complete before installation of suspension system.

C) Protection: Protect completed work above suspension system from damage during installation of suspension system components.

D) Examine areas to receive materials for conditions which will adversely affect installation. Provide written report of discrepancies.

E) Do not start work until unsatisfactory conditions are corrected.

F) Work to be concealed. Verify work above ceiling suspension system is completed and installed in manner which will not affect layout and installation of suspension system components.

9. INSTALLATION

A) Install in accordance with ASTM C-636 installation standard, the U.L. fire rating classification, any other applicable code requirements, and manufacturer's recommendations.

B) Lateral bracing:

   1. Provide lateral bracing as required by pertinent codes and regulations.
   2. Secure lateral bracing to structural members. Secure at right angles to the direction of the partition and four ways in large ceiling areas.

C) Hanger wires:

1. Spacing: Space hanger wires on main tees a maximum of 48 inches and as specified by U.L. fire resistance directory, attaching hangers directly to structure above.
2. Limitations: Do not support wire from mechanical and/or electrical equipment, piping, or other equipment located above ceiling.
3. Fixtures at ceiling: Provide additional hanger wires where lighting fixtures and/or air supply and return units occur in ceiling, minimum four (4) hangers per each item.

D) Hold down clips: Install hold down clips when infill material weights less than 1.0 lb./sq.ft.

E) Make all grid level within a tolerance of one in 1000 and straight within a tolerance of one in 1000.

F) Install acoustical tile and panels according to manufacturer's recommendations.

G) Provide all necessary materials and accessories to protect the LIGHTING FIXTURES, AND AIR DUCTS, AND DIFUSSERS such as to meet the specified fire-rated resistance.

10. CLEANING

A) In addition to other stipulated requirements for cleaning, completely remove finger prints and trades of soil from the surfaces of grid and acoustical materials, using only those cleaning materials recommended for that purpose by the manufacturer of the material being cleaned.

11. COMPLIANCE

A) Acoustical hung ceiling must comply with a fire resistance rating of 1 hour minimum as established by the NFPA 251, Standard Methods of Fire Tests of Building Construction and Materials.

B) Contractor must verify that the installed system will meet the specified resistance rating. If this is not the case notify the Architect immediately.

12. FINAL ACCEPTANCE

A) For final acceptance of the works specified under this section deliver to the Architect a letter signed by an officer of the firms manufacturing the grid suspension system and acoustical panels certifying] that the materials delivered to the project comply in all respects with the provisions of this section of the Specifications and Drawings.

B) For final acceptance of the works the Contractor must certify that the grid suspension system and the acoustical panels have been installed following manufacturer's recomendations and will meet the established fire resistance rating.

(SERVER-ADMIN-0618-ESPECIFICACIONES-09-510)

SECTION 09650: RESILIENT FLOORING

1. SCOPE

   A) Provide resilient flooring and base where shown on the drawings, as specified in the drawings and herein, and as needed for a complete and proper installation.

2. QUALITY ASSURANCE

   A) Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

   B) Provide materials obtained from only one source for each type of tiles and color to minimize variations in appearance and quality.

3. SUBMITTALS

   A) Product data: Within 45 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
      1. Materials list of items proposed to be provided under this section;
      2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
      3. Samples of each item, color, and pattern available in the specified grades from the proposed manufacturers;
      4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the work.

4. PRODUCT HANDLING

   A) Delivery of materials: Deliver materials in original unopened packages, clearly labeled with manufacturer's

name, item description, specification number, type and class, as applicable.

B) Inspection: Promptly inspect delivered materials; file freight claims for damage during shipment and order replacement material, as required. Do not install damaged or obviously faulty components.

C) Storage: Store in manner that will prevent war page, scratches, or damage of any kind. Prevent interference to/by other trades and any other adverse job conditions due to storage locations or methods.

D) Handling: Handle in such manner to insure against racking, distortion or physical damage of any kind.

5. EXTRA STOCK

A) Deliver to the Owner for his use in future modifications an extra stock of approximately 10% of each color and pattern in each material installed under this section, packaging each type of material separately, distinctly marked, and adequately protected against deterioration.

6. PRODUCTS

A) General

1. Provide colors and patterns as selected by the Architect from standard colors and patterns of the approved manufacturer in the specified type.

2. Adhesives:

a. Provide waterproof and stabilized type adhesive as recommended by the manufacturer of the material being installed.

b. Asphalt emulsions and other non-waterproof adhesives will not be acceptable.

c. Concrete slab primer: Provide non-staining type as required and as recommended by the manufacturer of the material being installed.

B) Resilient Materials

1. Heterogeneous Sheet vinyl flooring:
   a. Thickness: 0.080 inch
   b. Size: 12’ wide x 37’ long, Roll stock (standard)
   c. Manufacturer as specified in drawings.
2. Base:
   a. Provide base of the manufacturer and dimensions specified in the drawings.

C) Other Materials

1. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

7. SURFACE CONDITIONS

A) Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

8. PREPARATION

A) Subfloors:

1. Verify that substrate is smooth, level, at required finish elevation, and without more than 1/8" in 10'-0" variation from level or slopes shown on the drawings.
2. If there are existing irregularities on the surface to receive the tile, provide a mastic underlayment to level the surface. The maximum thickness of the underlayment application shall 1/8 inch. Any thickness greater than 1/8 inch should be applied in two or more applications not to exceed 3/8" total thickness.
3. Prior to laying materials, broom clean or vacuum the surfaces to be covered, and inspect the subfloors.

B) Priming:

1. Apply concrete slab primer if so recommended by the resilient flooring manufacturer.
2. Apply in accordance with the manufacturer's recommendations as approved by the Architect.

9. INSTALLATION

A) General:

1. Install materials only after finishing operations, including painting, have been completed.
2. Verify that moisture content of concrete slabs, building air temperature, and relative humidity are within the limits recommended by the manufacturers of the materials used.
3. Maintain reference markers, holes, and openings that are in place or plainly marked for future cutting by repeating on the finish surface as marked in the sub floor. Use chalk or other non-permanent marking device.
4. Install resilient flooring in strict accordance with the latest edition (available at the time of installation) of flooring manufacturer’s installation instructions.

B) Installing resilient sheet vinyl:

1. General Installation Instructions:
   a. Cut order pieces should be rolled face out on a core to take to the job site. Otherwise, the roll will flatten or “oval,” making it difficult to get the floor covering to lay flat when unrolled.
   b. The floor covering, adhesive, and room temperature must be kept at a minimum temperature of 65°F with a maximum of 90°F for at least 48 hours before and during, and 48 hours after installation.
   c. All subfloor patching on and below grade must be done with a quality cementitious floor patch or embossing leveler as appropriate.

d. Never install Mannington sheet goods over residual asphalt-type (cut back) adhesive. It can bleed through the new floor covering. Residual asphalt type adhesive must be removed or isolated from the finished flooring by providing a mechanical barrier, such as Mannington MVP-2023.
e. Should only be installed on properly prepared concrete substrates. (See concrete section below.) Do not install Realities and Primus products on wood panel subfloors.
f. All seams must be heat welded with Mannington solid color weld rod.

2. Subfloor Information:
   a. Careful and correct preparation of the subfloor is a major part of a satisfactory sheet floor covering installation. Roughness or unevenness of the subfloor will telegraph through the new floor covering, resulting in an unsightly surface and excessive wear on high spots. Proper subfloor selection and preparation are essential for a trouble-free job.
      i. Wood subfloors – MANNINGTON COMMERCIAL PRODUCTS REALITIES AND PRIMUS SHOULD NOT BE INSTALLED OVER WOOD PANEL SUBFLOORS.
      ii. Concrete Subfloors:
      1) Concrete subfloors must be dry, smooth, and free from dust, solvent, paint, wax, grease, oil, asphalt sealing compounds and other extraneous materials. The surface must be hard and dense, and free from powder or flaking.
      2) New concrete slabs must be thoroughly dry (at least six (6) weeks) and completely cured. Curing agents, surface hardeners and other additives may cause adhesive bonding failure. These should be removed by sanding or grinding.
      3) All concrete slabs shall be tested for moisture regardless of age or grade

level before installing floor covering material.

4) Concrete floors with a radiant heating system are satisfactory, provided the temperature of the floor does not exceed 90°F at any point.

5) Holes, grooves, and other depressions must be filled with Mannington MVP-2023 patching and leveling compound (or equivalent), and troweled smooth and feathered even with the surrounding surface.

C) Cutting and Fitting:

1. It is imperative that the material, adhesive and job site be maintained at a minimum ambient temperature of 65°F or a maximum of 90°F 48 hours before, during and 48 hours after installation.
2. If the material has been stored at colder temperatures, it will be necessary to unroll the material and allow it to relax overnight before proceeding with the installation.
3. If the job site is complex and requires a precise fit, traditional pattern scribing techniques should be used.
4. The material may also be fit using direct scribing techniques. Once the material has been fit, it will be necessary to tube lap half of the sheet back to expose the underfloor for adhesive application.
5. Care should be taken when folding the material back. Always fold the material in a wide radius to avoid sharp kinks and creases which may cause breaks in the product.

D) Adhesive Application:

1. After the material has been trimmed to fit the room, it should be tubed or lapped back to expose the underfloor.
2. On porous substrates, V-88 adhesive should be applied with a 1/16" wide, 1/32" deep, spaced 1/32" apart, notched trowel.
3. Follow all directions on adhesive container.

4. The adhesive must be spread over 100% of the exposed subfloor, leaving no gaps or puddles. Uniform coverage can be maintained by keeping the trowel clean and properly notched.
5. After the adhesive has been applied, roll the sheet forward into the adhesive to eliminate trapping air. Do not drop or flop the material into the adhesive. Roll the floor covering with a three-section 100 lb. or heavier floor in both directions. After the first half of the sheet has been adhered and rolled, fold back the second half and repeat the procedure.
6. Wait 1-2 hours then re-roll again to ensure full contact and to remove any trapped air. CAUTION: When providing open time, do not permit the adhesive to 'skin' over or dry. Too much open time will result in insufficient bonding.

E) Seaming:

1. Lay out resilient sheet vinyl flooring in conformance with the approved seaming diagram.
2. Realities and Primus are available only in 12' widths. Choose product width to eliminate unnecessary seams and minimize waste. When seaming is required with Mannington Commercial heterogeneous sheet flooring, the materials should be positioned Reverse Sheets for seaming.
3. The construction of heterogeneous flooring requires that the seams be cut using the trace cutting technique.
4. The selvage edge of one sheet should be straight-edged approximately 3/8" from the edge.
5. Position the sheets in such a manner that the straight-edged is approximately 3/8" from the edge.
6. Carefully trace along the edge of the top sheet with a utility knife with a sharp blade or a cutting tool designed for this purpose. Remove the trimmed selvage edge of the bottom sheet. Once the seams are cut, weigh the sheets and tube or lap back the sheets to expose the underfloor. Apply the appropriate Mannington adhesive using the correctly notched trowel over 100% of the exposed underfloor.
7. After providing sufficient open time for the adhesive, lay the straight-edged sheet in to the

adhesive first and then lay in the second sheet.

8. Roll the adhered areas to within about 6" of the seam line with a 100 lb. three-section floor roller.
9. Roll the seam area with a hand seam roller to bring the seam edges level. Re-roll the entire adhered area with the 100 lb. floor roller.
10. Thoroughly clean the seam area and wipe dry.

F) Heat Welding Heterogeneous Flooring:

1. Seams may be heat-welded using coordinating solid color weld rod.
2. Wait at least 24 hours after initial installation to allow the adhesive to cure before grooving Realities and Primus to receive the heat weld rod.
3. Proper temperature of the heat welding tool is critical to the success of this process. Heat welding is always dependent on speed of application and temperature. Practice on a scrap piece of material to determine optimum speed and temperature.
4. After the weld rod has cooled, trim the applied weld rod in two steps. Always use a trim plate with a sharp spatula trim knife for the first pass. Trim weld rod flush with the spatula knife, being careful to not gouge the vinyl surface.
5. Mannington Commercial Heat Weld Rod is color coordinated for use with Realities and Primus. Contrasting colors may be used if so desired.

G) Heat Welded Seam Sealing:

1. Apply Mannington Quantum Guard HP Seam Coater to all heat welded seams after weld rod installation is complete. Follow all manufacturer’s instructions.

H) Cautions and Miscellaneous:

1. Do not place heavy items on newly installed floor covering for at least 48 hours after completion of the installation. Heavy furniture should be equipped with suitable non-staining, wide-bearing casters.
2. Furniture should be moved onto the newly installed floor using an appliance hand truck over hardboard runways.
3. Floor covering subjected to excessive heat and

light exposure is subject to thermal degradation. Use appropriate precautions to minimize potential effects on the floor covering.

4. Oil or petroleum-based products can result in surface staining. Do not track asphalt driveway sealer or automobile oil drips on to the vinyl floor covering.
5. Use non-staining walk-off mats at building entrances to remove excess dirt and grit from foot traffic – rubber can discolor vinyl floor covering.

I) Installing base:
1. Install base where shown on the drawings.
2. Use factory-performed exterior corners, and factory-preformed or job-mitered interior corners.

10. CLEANING AND PROTECTING

A) Remove excess adhesive and other blemishes from exposed surfaces, using neutral cleaner recommended by the manufacturer of the resilient materials.

11. COMPLIANCE

A) The Contractor must verify that the specified material will meet the requirements of Class I Interior Floor Finish as specified in the National Protection Association's Life Safety Code, latest edition (NFPA 101). If the specified material does not meet this requirements, notify the Architect immediately.

12. FINAL ACCEPTANCE

A) For final acceptance of the works specified under this section deliver to the Architect a letter signed by an officer of the firms manufacturing the tiles certifying that the materials delivered to the project comply in all respects with the provisions of this section of the specifications and drawings. Also the Contractor must certify that the materials have been installed following manufacturer's recommendations and will meet the specified floor finish requirements.

SECTION 09910: PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A) Work of this Section includes all labor, materials, equipment, and services necessary to complete the painting and finishing as shown on the construction documents and/or specified herein, including, but not limited to, the following:

1. Prime coats which may be applied in shop under other sections.
2. Prime painting unprimed surfaces to be painted under this Section.
3. Painting items furnished with a prime coat of paint, including touching up of or repairing of abraded, damaged or rusted prime coast applied by others.
4. Painting ferrous metal (except stainless steel) exposed to view.
5. Painting galvanized ferrous metals exposed to view.
6. Painting interior concrete block exposed to view.
7. Painting gypsum drywall exposed to view.
8. Painting of wood exposed to view, except items which are specified to be painted or finished under other Sections of these specifications. Back painting of all wood in contact with concrete, masonry or other moisture areas.
9. Painting pipes, pipe coverings, conduit, ducts, insulation, hangers, supports and other mechanical and electrical items and equipment exposed to view.
10. Painting surfaces above, behind or below grilles, gratings, diffusers, louvers lighting fixtures, and the like, which are exposed to view through these items.
11. Painting includes shellacs, stains, varnishes, coatings specified, and striping or markers and identity markings.
12. Incidental painting and touching up as required to produce proper finish for painted surfaces, including touching up of factory finished items.

13. Painting of any surface not specifically mentioned to be painted herein or on construction documents, but

for which painting is obviously necessary to complete the job, or work which comes within the intent of these specifications, is to be included as though specified.

1.2 RELATED WORK

A) Section 04 MASONRY MORTARING: Masonry Repairs.

B) Section 04 MASONRY GROUTING: Masonry Repairs.

C) Division 08 DOORS AND WINDOWS: Shop prime painting of steel and ferrous metals.

D) Division 15 PLUMBING: Shop prime painting of steel and ferrous metals.

E) Division 15 HEATING: VENTILATION AND AIR-CONDITIONING: Shop prime painting of steel and ferrous metals.

F) Division 16 ELECTRICAL: Shop prime painting of steel and ferrous metals.

G) Division 17 COMMUNICATIONS: Shop prime painting of steel and ferrous metals.

1.3 SUBMITTALS

B) Submit in accordance with Section 01340. Submittals, an equal and substitution.

C) Painter qualifications.

D) Manufacturer’s Literature and Data:

1. Before work is started, or sample panels are prepared, submit manufacturer’s literature and technical data, the current Master Painters Institute (MPI) Approved Product List” indicating brand label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use subsequent MPI “Approved Product List”, however, only one (1) list may be used for the entire contract and each coating system is to be from a single manufacturer. All

coats on a particular substrate must be from a single manufacturer. No variation from the MPI “Approved Product List” where applicable is acceptable.

E) Sample Panels:

1. After painters’ materials have been approved and before work is stated, submit sample panels showing each type of finish and color specified.
2. Panels to Show Color: Composition board, 100 x 250 mm (4 x 10 inch).
3. Panel to Show Transparent Finishes: Wood of same species and grain pattern as wood approved for use, 100 x 250 mm (4 x 10-inch face) minimum, and where both flat and edge grain will be exposed, 250 mm (10 inches) long by sufficient size, 50 x 50 mm (2 x 2 inch) minimum or actual wood member to show complete finish.
4. Attach labels to panel stating the following:
   a. Federal Specification Number or manufacturers name and product number of paints used.
   b. Product type and color.
   c. Name of project.
5. Strips showing not less than 50 mm (2 inch) wide strips of undercoats and 100 mm (4 inch) wide strip of finish coat.

E) Sample of identity markers if used.

F) Manufacturers’ Certificates indicating compliance with specified requirements:

1. Manufacturer’s paint substituted for Federal Specification paints meets or exceeds performance of paint specified.
2. High temperature aluminum paint.
3. Epoxy coating.
4. Intumescent clear coating or fire-retardant paint.
5. Plastic floor coating.

1.4 DELIVERY AND STORAGE

A) Delivery materials to site in manufacturer’s sealed container marked to show following:

1. Name of manufacturer.
2. Product type.
3. Batch number.
4. Instructions for use.
5. Safety precautions.

B) In addition to manufacturer's label, provide a label legibly printed as following:

1. Federal Specification Number, where applicable, and name of material.
2. Surface upon which material is to be applied.
3. Specify Coat Types: Prime: body; finish; etc.

C) Maintain space for storage, and handling of painting materials and equipment in a ventilated, neat and orderly condition to prevent spontaneous combustion from occurring or igniting adjacent items.

D) Store materials at site at least 24 hours before using, at a temperature between 7 and 30 degrees C (45 and 85 degrees F).

1.5 QUALITY ASSURANCE

A) Qualification of Painters: Use only qualified journeyman painters for the mixing and application of paint on exposed surfaces. Submit evidence that key personnel have successfully performed surface preparation and application of coating on a minim of three (3) similar projects within the past three (3) years.

B) Paint Coordination: Provide finish coast which are compatible with the prime paints used. Review other Sections of these specifications in which prime paints are to be provided to ensure compatibility of the total coating system for the various substrates. Upon request from other subcontractors, furnish information on the characteristics of the finish materials proposed to be used, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and reprime as required. Notify the Owner in writing of any anticipated problems using the coating systems as specified with substrates pried by others.

1.6 MOCK-UP PANEL

A) In addition to the samples specified herein to be submitted for approval, apply in the field, at their final location, each type and color of approved paint materials, applied 3.05 m (10 feet) wide, floor to ceiling of wall surfaces, before proceeding with the remainder of the work, for approval by the Owner ‘representative. Paint mock-ups to include one (1) door and frame assembly.

B) Finish and textures approved by Owner ‘representative will be used as a standard of quality and workmanship for remainder of work.

C) Repaint individual areas which are not approved, as determined by the Owner ‘representative, until approval is received.

1.7 REGULATORY REQUIREMENTS

A) Paint materials are to conform to the restrictions of the local Environmental and Toxic Control jurisdiction.

1. Volatile Organic Compounds (VOC) Emissions Requirements: Field-applied paints and coatings that are inside the waterproofing system to not exceed limits of authorities having jurisdiction.
2. Lead-Base Paint:
   A. Comply with Section 410 of the Lead-Based Paint Poisoning Prevention Act, as amended, and with implementing regulations promulgated by Secretary of Housing and Urban Development.
   B. Regulations concerning prohibition against use of lead-based paint in federal and federally assisted construction, or rehabilitation of residential structures are set forth in Subpart F, Title 24, Code of Federal Regulations, Department of Housing and Urban Development.
   C. Do not use coatings having a lead content over 0.06 percent by weight of non-volatile content.
3. Asbestos: Provide materials that do not contain asbestos.
4. Chromate, Cadmium, Mercury, and Silica: Provide materials that do not contain zinc-chromate,

strontium-chromate, Cadmium, mercury or mercury compounds or free crystalline silica.

5. Human Carcinogens: Provide materials that do not contain any of the ACGIH-BKLT and ACGHI-DOC confirmed or suspected human carcinogens.
6. Use high performance acrylic paints in place of alkyd paints.

1.8 SAFETY AND HEALTH

A) Apply paint materials using safety methods and equipment in accordance with the following:

1. Comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis (AHA). The AHA is to include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

B) Safety Methods Used During Paint Application: Comply with the requirements of SSPC PA Guide 10.

C) Toxic Materials: To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

1. The applicable manufacturer’s Material Safety Data Sheets (MSDS) or local regulation.
2. 29 CFR 1910.1000.
3. ACHIH-BKLT and ACGHI-DOC, threshold limit values.

1.9 APPLICABLE PUBLICATIONS

A) Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

B) American Conference of Governmental Industrial Hygienists (ACGIH):

ACGIH TLV-BKLT-2012…… Threshold Limit Values (TLV) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs).

ACGIH TLV-DIC-2012..... Documentation of Threshold Limit Values and Biological Exposure Indices, (Seventh Edition)

C) ASME International (ASME):

A13.1-07(R2013)..... Scheme for the Identification of Piping Systems.

D) Code of Federal Regulation (CFR):

40 CFR 59..... Determination of Volatile Matter Content, Water Content, Density Volume Solids, and Weight Solids of Surface Coating.

E) Commercial Item Description (CID):

A-A-1272A..... Plaster Gypsum (Spackling Compound)

F) Federal Specifications (Fed Spec):

TT-P-1411A..... Paint, Copolymer-Resin, Cementitious (For Waterproofing Concrete and Masonry Walls) (CEP)

G) Master Painters Institute (MPI):

1..... Aluminum Paint
3..... Primer, Alkali Resistant, Water Based
4..... Interior/Exterior Latex Block Filler
5..... Exterior Alkyd Wood Primer
6..... Exterior, Latex for Exterior Wood Primer
7..... Exterior Oil Wood Primer
8..... Exterior Alkyd, Flat MPI Gloss Level 1
9..... Exterior Alkyd Enamel MPI Gloss Level 6
10..... Exterior Latex, Flat
11..... Exterior Latex, Semi-Gloss
15..... Exterior Latex, Low Sheen (MPI Gloss Level 3-4)
17..... Primer, Bonding, Waterbased

18..... Organic Zinc Rich Primer
22..... Aluminum Paint, High Heat (up to 590% - 1100F)
23..... Primer, Metal, Surface Tolerant
27..... Exterior/Interior Alkyd Floor Enamel, Gloss
31..... Polyurethane, Moisture Cured, Clear Gloss
36..... Knot Sealer
39..... Primer, Latex, for Interior Wood
40..... Exterior, Latex High Build
42..... Textured Coating, Latex, Flat
43..... Interior Satin Latex, MPI Gloss Level 4
44..... Interior Low Sheen Latex, MPL Gloss Level 2
45..... Interior Primer Sealer
46..... Interior Enamel Undercoat
47..... Interior Alkyd, Semi-Gloss, MPI Gloss Level 5
48..... Interior Alkyd, Gloss MPI Gloss Level 6
50..... Interior Latex Primer Sealer
51..... Interior Alkyd, Eggshell, MPI Gloss Level 3
52..... Interior Latex, MPI Gloss Level 3
53..... Interior Latex, Flat, MPI Gloss Level 1
54..... Interior Latex, Semi-Gloss, MPI Gloss Level 5
59..... Interior/Exterior Alkyd Porch & Floor Enamel, Low Gloss
60..... Interior/Exterior Alkyd Porch & Floor Paint, Low Gloss
66..... Interior Alkyd Fire Retardant, Clear Top-Coat (ULC Approved)
67..... Interior Latex Fire Retardant, Top-Coat (ULC Approved)
68..... Interior/Exterior Latex Porch & Floor Paint, Gloss
71..... Polyurethane, Moisture Cured, Clear, Flat
77..... Epoxy Cold Cured, Gloss
79..... Marine Alkyd Metal Primer

90	Interior Wood Stain, Semi-Transparent
91	Wood Filler Paste
94	Exterior Alkyd, Semi-Gloss
95	Fast Drying Metal Primer
98	High Build Epoxy Coating
99	Sealer, Water-based, for Concrete Floors
101	Epoxy Anti-Corrosive Metal Primer
107	Primer, Rust Inhibitive, Water-based, Flat
108	High Build Epoxy Coating, Low Gloss
113	Elastomeric, Pigmented, Exterior, Water-based, Flat
114	Interior Latex, Gloss
115	Epoxy-Modified Latex, Interior Gloss (MPI gloss Level 6)
118	Dry Fall, Latex Flat
119	Exterior Latex, High Gloss (acrylic)
134	Galvanized Water Based Primer
135	Non-Cementitious Galvanized Primer
138	Interior High Performance Latex, MPI Gloss Level 2
139	Interior High Performance Latex, MPI Gloss Level 3
140	Interior High Performance Latex, MPI Gloss Level 4
141	Interior High Performance Latex, (SG) MPI Gloss Level 5
144	Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 2)
145	Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 3)
146	Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 4)
151	Light Industrial Coating, Interior, Water-based, (MPI Gloss Level 3)
153	Light Industrial Coating, Interior, Water-based, (MPI Gloss Level 4)

163……	Exterior Water Based, Semi-Gloss Light Industrial Coating, MPI Gloss Level 5
164……	Exterior, Water Based, Gloss, Light Industrial Coating, MPI Gloss Level 6

H) Society for Protective Coatings (SSPC):

SSPC SP 1-82(R2004)……	Solvent Cleaning
SSPC SP 1-82(R2004)……	Hand Tool Cleaning
SSPC SP 3-28(R2004)……	Power Tool Cleaning
SSPC SP 10/NACE No.2……	Near-White Blast Cleaning
SSPC PA Guide 10……	Guide to Safety and Health Requirements

I) Maple Flooring Manufacturer’s Association (MFMA):

J) U.S. National Archives and Records Administration (NARA):

29 CFR 1910.1000……	Air Contaminants

K) Underwriter’s Laboratory (UL)

PART 2 – PRODUCTS

2.1 MATERIALS:

A) Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer’s technical data sheets for specified coatings and solvents.

2.2 PAINT PROPERTIES:

A) Use ready-mixed (including colors), except two component epoxies, polyurethanes, polyesters, paints having metallic powders packaged separately and paints requiring specified additives.

B) Where no requirements are given in the referenced specifications for primers, use primers with pigment and vehicle, compatible with substrate and finish coasts specified.

C) Provide undercoat paint produced by the same manufacturer as the finish coats. Use only thinners approved by the paint manufacturer and use only to recommended limits.

D) VOC Content: For field applications that are inside the weatherproofing system, paints and coating to comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1) Flat Paints and Coatings: 50 gram/liter.
2) Non-flat Paints and Coatings: 150 gram/liter.
3) Dry-Fog Coatings: 400 gram/liter.
4) Primers, Sealers, and Undercoaters: 200 gram/liter.
5) Anticorrosive and Antirust Paint applied to Ferrous Metals: 250 gram/liter.
6) Zinc-Rich Industrial Maintenance Primers: 340 gram/liter.
7) Pretreatment Wash Primers: 420 gram/liter.
8) Shellacs, Clear: 730 gram/liter.
9) Shellacs, Pigmented: 550 gram/liter.

E) VOC Test method for paints and coatings is to be in accordance with 40 CFR 59(EPA Method 24). Part 60, Appendix A with the exempt compounds 'content determined by Method 303 (Determination of Exempt Compounds) in the South Coast Air Quality Management District's (SCAQMD) "Laboratory Methods of Analysis for Enforcement Samples" manual.

2.3 PLASTIC TAPE:

A) Pigmented vinyl plastic film in colors.
B) Pressure sensitive adhesive back.
C) Widths as shown on construction documents.

2.4 BIOBASED CONTENT

A) Paint products shall comply with following bio-based standards for biobased materials:

Material Type	Percent by Weight
Interior Paint	20 percent biobased material
Interior Paint-Oil Based and Solvent Alkyd	67 percent biobased material
Exterior Paint	20 percent biobased material
Wood & Concrete Stain	39 percent biobased content
Polyurethane Coatings	25 percent biobased content
Water Tank Coatings	59 percent biobased content
Wood & Concrete Sealer-Membrane Concrete Sealers	11 percent biobased content
Wood & Concrete Sealer-Penetrating Liquid	79 percent biobased content

B) The minimum-content standards are based on the weight (not the volume) of the material.

PART 3 – EXECUTION

3.1 JOB CONDITIONS:

A) Safety: Observe required safety regulations and manufacturer's warning and instructions for storage, handling and application of painting materials.

1) Take necessary precautions to protect personnel and property from hazards due to falls, injuries, toxic fumes, fire, explosion, or other harm.
2) Deposit soiled cleaning rags and waste materials in metal containers approved for that purpose. Dispose of such items of the site at end of each day's work.

B) Atmospheric and Surface Conditions:

1) Do not apply coating when air or substrate conditions are:
   A) Less than 3 degrees C (5 degrees F) above dew point.
   B) Below 10 degrees C (50 degrees F) or over 35 degrees C (95 degrees F), unless specifically pre-approved by the COR and the product manufacturer. Under no circumstance are application conditions to exceed manufacturer recommendations.
   C) When the relative humidity exceeds 85 percent; or to damp or wet surfaces; unless otherwise permitted by the paint manufacturer's printed instructions.
2) Maintain interior temperatures until paint dries hard.
3) Do not exterior painting when it is windy and dusty.
4) Don not paint in direct sunlight or on surfaces that the sun will warm.
5) Apply only on clean, dry and frost-free surfaces except as follows:
   A) Apply water thinned acrylic and cementitious paints to damp (not wet) surfaces only when

allowed by manufacturer's printed instructions.

B) Concrete and masonry when permitted by manufacturer's recommendations, dampen surfaces to which water thinned acrylic and cementitious paints are applied with a fine mist of water on hot dry days to prevent excessive suction and to cool surface.

6) Varnishing:

A) Apply in clean areas and in still air.

B) Before varnishing vacuum and dust area.

C) Immediately before varnishing wipe down surfaces with a tack rag.

3.2 INSPECTION:

A) Examine the areas and conditions where painting and finishing are to be applied and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.3 GENERAL WORKMANSHIP REQUIREMENTS:

A) Application may be by brush or roller. Spray application only upon acceptance from the Owner' representative in writing.

B) Furnish to the Owner' representative a painting schedule indicating when the respective coasts of paint for the various areas and surfaces will be completed. This schedule is to be kept current as the job professes.

C) Protect work at all times. Protect all adjacent work and materials by suitable covering or other method during progress of work. Upon completion of the work, remove all paint and varnish spots from floors, glass and other surfaces. Remove from the premises all rubbish and accumulated materials of whatever nature not caused by others and leave work in a clean condition.

D) Remove and protect hardware, accessories, device plates, lighting fixtures, and factory finished work, and similar items, or provide in place protection. Upon

completion of each space, carefully replace all removed items by workmen skilled in the trades involved.

E) When indicated to be painted, remove electrical panel box covers and doors before painting walls. Paint separately and re-install after all paint is dry.

F) Materials are to be applied under adequate illumination, evenly spread and flowed on smoothly to avoid runs, sags, holidays, brush marks, air bubbles and excessive roller stipple.

G) Apply materials with a coverage to hide substrate completely. When color, stain, dirt or undercoats show through final coat of paint, the surface Is to be covered by additional coats until the paint film is of uniform finish, color, appearance and coverage, at no additional cost to the Owner.

H) All coats are to be dry to manufacturer’s recommendations before applying succeeding coasts.

I) All suction spots or “hot spots” in plaster after the applications of the first coat are to be touched up before applying the second coat.

J) Do not apply paint behind frameless mirrors that use mastic for adhering to wall surface.

3.4 SURFACE PREPARATION:

A) General:

1) The Contractor shall be held wholly responsible for the finished appearance and satisfactory completion of painting work. Properly prepare all surfaces to receive paint, which includes cleaning, sanding, and touching-up of all prime coasts applied under other Sections of the works. Broom cleans all spaces before painting is stared. All surfaces to be painted or finished are to be completely dry, clean and smooth.
2) See other sections of specifications for specified surface conditions and prime coat.

3) Perform preparation and cleaning procedures in strict accordance with the paint manufacturer's instructions and as herein specified, for each particular substrate condition.
4) Clean surfaces before applying paint or surface treatments with materials and methods compatible with substrate and specified finish. Remove any residue remaining from cleaning agents used. Do not use solvents, acid, or steam on concrete and masonry. Schedule the cleaning and painting so that dust and other contaminants from the cleaning process will not fall in wet, newly painted surfaces.
5) Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   A) Concrete: 12 percent.
   B) Fiber-Cement Board: 12 percent.
   C) Masonry (Clay and CMU's): 12 percent.
   D) Wood: 15 percent.
   E) Gypsum Board: 12 percent.
   F) Plaster: 12 percent.

B) Wood:

1) Sand to a smooth even surface and then dust off.
2) Sand surfaces showing raised grain smooth between each coat.
3) Wipe surface with a tack rag prior to applying finish.
4) Surface painted with an opaque finish:
   A) Coat knots, sap and pitch streaks with MPI 36 (Knot Sealer) before applying paint.
   B) Apply two coats of MPI 36 (Knot Sealer) over large knots.
5) After application of prime or first coat of stain, fill cracks, nail and screw holes, depressions and similar defects with wood filler paste. Sand the surface to make smooth and finish flus with adjacent surface.
6) Before applying finish coat, reapply wood filler paste if required, and sand surface to remove surface blemishes. Finish flus with adjacent surfaces.

7) Fill open grained wood such as oak, walnut, ash and mahogany with MPI 91 (Wood Filer Paste), colored to match wood color.
   A) Thin filler in accordance with manufacturer's instructions for application.
   B) Remove excess filler, wipe as clean as possible, dry, and sand as specified.

C) Ferrous Metals:

1) Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign matter in accordance with SSC-SP 1 (Solvent Cleaning).
2) Remove loose mill scale, rust, and paint, by hand or power tool cleaning, as defined in SSPC-SP2 (Hand Tool Cleaning) and SSPC-SP 3 (Power Tool Cleaning).
3) Fill dents, holes and similar voids and depressions in flat exposed surfaces of hollow steel doors and frames, access panels, roll-up steel doors and similar items specified o have semi-gloss or gloss finish with TT-F-322D (Filler, Two-Component Type, For Dents, Small Holes and Blow-Holes). Finish flus with adjacent surfaces.
   A) Fill flat head countersunk screw used for permanent anchors.
   B) Do not fill screws of item intended for removal such as glazing beads.
4) Spot prime abraded and damaged areas in shop prime coat which expose bare metal with same type of paint used for prime coat. Feather edge of spot prime to produce smooth finish coat.
5) Spot prime abraded and damaged areas which expose bare metal or factory finished items paint as recommended by manufacturer or item.

D) Zinc-Coated (Galvanized)Metal, Aluminum Specified Painted:

1) Clean surfaces to remove grease, oil and other deterrents to paint adhesion in accordance with SSPC-SP 1 (Solvent Cleaning).
2) Spot coat abraded and damaged areas of zinc-coating which expose base metal on hot-dip zinc-coated

items with MPI 18 (Organic Zinc Rich Coating). Prime or spot prime with MPI 134 (Waterborne Galvanized Primer) or MPI 135 (Non-Cementitious Galvanized Primer) depending on finish coat compatibility.

E) Masonry, Concrete, Cement Board, Cement Plaster and Stucco:

1) Clean and remove dust, dirt oil, grease efflorescence, form release agents, laitance, and other deterrents to paint adhesion.
2) Use emulsion type cleaning agents o remove oil, grease, paint and similar products. Use of solvents, acid, or steam is not permitted.
3) Remove loose mortar in masonry work.
4) Replace mortar and fill open joints, holes, cracks, and depressions with new mortar specified in Section 04 05 13, MASONRY MORTARING Section 04 05 16, MASONRY GROUTING. Do not fill weep holes. Finish to match adjacent surfaces.
5) Neutralize Concrete floors to be painted by washing with a solution of 1.4 Kg (3 pounds) of zinc sulfate crystals to 3.8 L (1 gallon) of water, allow to dry three (3) days and brush thoroughly free of crystals.
6) Repair broken and spalled concrete edges with concrete patching compound to match adjacent surfaces as specified in Division 03, CONCRETE Sections. Remove projections to level of adjacent surface by griding or similar methods.

F) Gypsum Plaster and Gypsum Board:

1) Remove efflorescence, loose and chalking plaster or finishing materials.
2) Remove dust, dirt, and other deterrents to paint adhesion.
3) Fill holes, cracks, and other depressions with CID-A-A-1272A finished flush with adjacent surface, with texture to match texture of adjacent surface. Patch holes over 25 mm (1-inch) in diameter as specified in Section for plaster or gypsum board.

3.5 PAINT PREPARATION:

A) Thoroughly mix painting materials to ensure uniformity of color, complete dispersion of pigment and uniform composition.

B) Do not thin unless necessary for application and when finish paint is used for body and prime coats. Use materials and quantities for thinning as specified in manufacturer’s printed instructions.

C) Remove paint skins, then strain paint through commercial paint strainer to remove lumps and other particles.

D) Mix two (2) component and two (2) part paint and those requiring additives in such a manner as to uniformly blend as specified in manufacturer’s printed instructions unless specified otherwise.

E) For tinting required to produce exact shades specified, use color pigment recommended by the paint manufacturer.

3.6 APPLICATION:

A) Start of surface preparation or painting will be construed as acceptance of the surface as satisfactory for the application of materials.

B) Unless otherwise specified, apply paint in three (3) coats; prime, body, and finish. When two (2) coasts applied to prime coat are the same, first coat applied over primer is body coat and second coat is finishing coat.

C) Apply each coat evenly and cover substrate completely.

D) Allow not less than 48 hours between application of succeeding coats, except as allowed by manufacturer’s printed instructions, and approved by Owner’ representative.

E) Apply by brush or roller. Spray application for new or existing occupied spaces only upon approval by acceptance from Owner’ representative in writing.

1) Apply painting materials specifically required by manufacturer to be applied by spraying.
2) In new construction and in existing occupied spaces, where paint is applied by spray, mask or enclose with polyethylene, or similar air tight material with edges and seams continuously sealed including items specified in “Building and Structural Work Field Painting”; “Work not Painted”; motors, controls, telephone, and electrical equipment, fronts of sterilizes and other recessed equipment and similar prefinished items.

F) Do not paint in closed position operable items such as access doors and panels, window sashes, overhead doors, and similar items except overhead roll-up doors and shutters.

3.7 REFINISHING EXISTING PAINTED SURFACES:

A) Clean, patch and repair existing surfaces as specified under “Surface Preparation”. No “telegraphing” of lines, ridges, flakes, etc., through new surfacing is permitted. Where this occurs, sand smooth and re-finish until surface meets with Owner’s representative approval.

B) Remove and reinstall items as specified under “General Workmanship Requirements”.

C) Remove existing finishes or apply separation coats to prevent non compatible coatings from having contact.

D) Patched or Replaced Areas in Surfaces and Components: Apply spot prime and body coats as specified for new work to repaired areas or replaced components.

E) Except where scheduled for complete painting apply finish coat over plane surface to nearest break in plane, such as corner, reveal, or frame.

F) Refinish areas as specified for new work to match adjoining work unless specified or scheduled otherwise.

G) Coat knots and pitch streaks showing through old finish with MPI 36 (Knot Sealer) before refinishing.

H) Sand or dull glossy surfaces prior to painting.

I) Sand existing coating to a feather edge so that transition between new and existing finish will not show in finished work.

3.8 PAINT COLOR:

A) Subject to compliance with project requirements.

B) Coat Colors:

1) Color of priming coat: Lighter than body coat.
2) Color of body coat: Lighter than finish coat.
3) Color prime and body coats to not show through the finish coat and to mask surface imperfections or contrasts.

C) Painting, Caulking, Closures, and Fillers Adjacent to Casework:

1) Paint to match color of casework where casework has a paint finish.
2) Paint to match color of wall where casework is stainless steel, plastic laminate, or varnished wood.

3.9 BUILDING AND STRUCTURAL WORK FIELD PAINTING:

A) Painting and finishing of interior and exterior work except as specified here-in-after.

1) Painting and finishing of new and existing work including colors and gloss of finish selected is specified on construction drawings.
2) Painting of disturbed, damaged and repaired or patched surfaces when entire space is not scheduled for complete repainting or refinishing.
3) Painting of ferrous metal and galvanized metal.
4) Identity painting and safety painting.

B) Building and Structural Work not Painted:

1) Prefinished items:

A) Casework, doors, elevator entrances and cabs, metal panels, wall covering, and similar items specified factory finished under other sections.
B) Factory finished equipment and pre-engineered metal building components such as metal roof and wall panels.

2) Finished surfaces:
A) Hardware except ferrous metal.
B) Anodized aluminum, stainless steel, chromium plating, copper, and brass, except as otherwise specified.
C) Signs, fixtures, and other similar items integrally finished.

3) Concealed surfaces:
A) Inside dumbwaiter, elevator and duct shafts, interstitial spaces, pipe basements, crawl spaces, pipe tunnels, above ceilings, attics, except as otherwise specified.
B) Inside walls or other spaces behind access doors or panels.
C) Surfaces concealed behind permanently installed casework and equipment.

4) Moving and operating parts:
A) Shafts, chains, gears, mechanical and electrical operators, linkages, and sprinkler heads, and sensing devices.
B) Tracks for overhead or coiling doors, shutters, and grilles.

5) Labels:
A) Code required label, such as Underwriters Laboratories Inc., Intertek Testing Service or Factory Mutual Research Corporation.
B) Identification plates, instruction pates, performance rating, and nomenclature.

6) Galvanized metal:
A) Exterior chain link fence and gates, corrugated metal areaways, and gratings.
B) Gas Storage Racks.
C) Except where specifically specified to be painted.

7) Metal safety treads and nosing’s.

8) Gaskets.

9) Structural steel encased in concrete, masonry, or other enclosure.
10) Structural steel to receive spayed-on fire proofing.
11) Ceilings, walls, columns in interstitial spaces.
12) Ceilings, walls, and columns in pipe basements.

3.10 PROTECTION CLEAN UP, AND TOUCH-UP:

A) Protect work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.

B) Upon completion, clean paint from hardware, glass and other surfaces and items not required to be painted of paint drops or smears.

C) Before final inspection, touch-up or refinished in a manner to produce solid even color and finish texture, free from defects in work which was damaged or discolored.

3.11 PAINTING SCHEDULE:

A) The project Painting Schedule is specified in the Construction Drawings.

B) Final color schedule will be provided by the Architect once the Paint Manufacturer is submitted by Contractor and approved by the Architect.

SECTION 09950: CARPETING

1. SCOPE

   A. Work included: Provide carpeting and carpet accessories where shown on the Drawings, as specified herein, and as needed for a complete and proper carpet-and-pad installation.

   B. Related work:

      1. Documents affecting work of this Section include, but are not necessary limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.

2. QUALITY ASSURANCE

   A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

3. SUBMITTALS

   A. Comply with pertinent provisions of Section 01340.

   B. Product data: Within 60 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:

      1. Materials list of items proposed to be provided under this Section;
      2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
      3. Shop Drawings showing location of seams and locations and types of carpet metal and accessories.
      4. Samples of the full range of colors, and patterns of available from the proposed manufacturers in the specified qualities;
      5. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.

   C. After the Architect has selected the color and pattern, submit three Samples of each color and pattern from the stock proposed to be installed. Secure the Architect’s approval of these Samples prior to installation.

4. PRODUCT HANDLING

   A. Comply with pertinent provisions of Section 01614.

B. Inspection: Promptly inspect delivered materials; file freight claims for damage during shipment and order replacement material, as required. Do not install damaged or obviously faulty components.

C. Storage: Store in manner that will prevent warpage, scratches, or damage of any kind. Prevent interference to/by other trades and any other adverse job conditions due to storage locations or methods.

D. Handling: Handle in such manner to insure against racking, distortion or physical damage of any kind.

5. CARPET

A. Provide colors and patterns as selected by the Architect from standard colors and patterns of the approved manufacturer in the specified type.

B. Provide carpeting with at least the following minimum attributes:

1. Weave: Velvet woven through the back.
2. Surface: Alternating cut and loop.
3. Gage: 108-108.
4. Stitches: Eight per inch.
5. Pile height: 0.255”.
6. Face yarn: Four-ply Antron III continuous filament nylon.
7. Face yarn weight: 34.7 oz per sq. yd.
8. Total weight: 65.3 oz per sq. yd.
9. Backing material: Polypropylene.
10. Dye method: Yarn dyed knit-de-knit.
11. Static parameter: 300 V at 20% relative humidity at 70 degrees F.
12. Flame spread: 64 maximum.
13. Smoke developed: 121 maximum.
14. Installation method: Tackless strips.

6. OTHER MATERIALS

A. Provide seam adhesive such as W.W. Henry Company No. 246, Roberts Company No. 41-0502, or an equal approved by the Architect and recommended for the purpose by the manufacturer of the proposed carpet.

B. Provide Allen Industries 50 oz. “Star-Tex” combination pad, or equal approved in advance by the Architect, under all carpet of this Section, unless otherwise specified in drawings.

C. Provide other materials, including tackles strips, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

7. SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

8. SURFACE PREPARATION

A. Make substrata level and free from irregularities. Assure one constant floor height after carpet is installed, filling low spots and grinding high spots as required.

9. INSTALLATION

A. General:

1. Install the approved pad in strict accordance with the manufacturer's recommendations as approved by the Architect, lightly butting the joints, and providing a smooth underlayment.
2. Scribe the carpet accurately to vertical surfaces.
3. Align the lines of carpet, as woven; using no fill strips less than 6" wide, laying all carpet in the same direction unless specifically directed otherwise by the Architect.
4. Where carpeting is used on the walls, install as directed by the manufacturer, and trim the top edge and exposed vertical edges with a brass cap approved by the Architect.

B. Seams:

1. Locate seams only where shown on the approved Shop Drawings or where specifically otherwise approved by the Architect.
2. Locate seams to the maximum extent practicable out of the way of traffic.
3. Fabricate seams by the compression method, using a butt joint, and properly bead and seal.
4. Make seams as inconspicuous as possible, flat unpuckered, and completely free from glue on the exposed surfaces.
5. Do not stretch seams.

C. In addition to the cleaning requirements stated elsewhere, thoroughly clean carpet and adjacent surfaces prior to final acceptance of the carpeted areas by the Owner.

10. PROTECTION

A. Provide a heavy non-staining or plastic walkway as required over carpeting in direction of traffic, maintaining intact until carpeted space is accepted by the Owner.

11. SURPLUS MATERIAL

A. Allow the Owner to inspect and select form scrap carpet remaining after the installation. Bundle, wrap in burlap, and deliver to the Owner the carpet scraps selected by him.

12. COMPLIANCE

A. The Contractor must verify that the specified material will meet the requirements of Class I Interior Floor Finish as specified in the National Protection Association's Life Safety Code, latest edition (NFPA 101). If the specified material does not meet these requirements, notify the Architect immediately.

13. FINAL ACCEPTANCE

A. For final acceptance of the works specified under this section deliver to the Architect a letter signed by an officer of the firms manufacturing the carpet certifying that the materials delivered to the project comply in all respects with the provisions of this section of the specifications and drawings. Also the Contractor must certify that the materials have been installed following manufacturer's recommendations and will meet the specified floor finish requirements.

END OF SECTION

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Concrete equipment base construction requirements.
3. Equipment nameplate data requirements.
4. Labeling and identifying mechanical systems and equipment is specified in Division 15 Section "Mechanical Identification."
5. Nonshrink grout for equipment installations.
6. Field-fabricated metal and wood equipment supports.
7. Installation requirements common to equipment specification Sections.
8. Mechanical demolition.
9. Cutting and patching.
10. Touchup painting and finishing.

B. Pipe and pipe fitting materials are specified in piping system Sections.

1.3 DEFINITIONS

A. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

C. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

E. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

F. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for following piping specialties:

1. Mechanical sleeve seals.
2. Identification materials and devices.

C. Samples of color, lettering style, and other graphic representation required for each identification material and device.

D. Shop drawings detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

E. Coordination drawings for access panel and door locations.

F. Prepare coordination drawings according to Division 1 Section "Submittals" to a 1/4 inch equals 1 foot scale or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:

1. Proposed locations of piping, ductwork, equipment, and materials. Include the following:

a. Planned piping layout, including valve and specialty locations and valve stem movement.
b. Planned duct systems layout, including elbow radii and duct accessories.
c. Clearances for installing and maintaining insulation.
d. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
e. Equipment service connections and support details.
f. Exterior wall and foundation penetrations.
g. Fire-rated wall and floor penetrations.
h. Sizes and location of required concrete pads and bases.

2. Scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

G. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

1.5 QUALITY ASSURANCE

A. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code--Steel."

B. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

C. ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

D. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Protect stored plastic pipes from direct sunlight. Support to prevent sagging and bending.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of electrical services.

F. 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.

G. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."

H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 15 for special joining materials not listed below.

B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, except where thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.

2. ASME B16.20 for grooved, ring-joint, steel flanges.
3. AWWA C110, rubber, flat face, 1/8 inch thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.

D. Plastic Pipe Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, except where other type or material is indicated.

E. Solder Filler Metal: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10 percent lead content.

2. Alloy Sn50: Tin (50 percent) and lead (50 percent).
3. Alloy E: Tin (approximately 95 percent) and copper (approximately 5 percent), having 0.10 percent maximum lead content.
4. Alloy HA: Tin-antimony-silver-copper-zinc, having 0.10 percent maximum lead content.
5. Alloy HB: Tin-antimony-silver-copper-nickel, having 0.10 percent maximum lead content.
6. Alloy Sb5: Tin (95 percent) and antimony (5 percent), having 0.20 percent maximum lead content.

F. Brazing Filler Metals: AWS A5.8.

1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements: Manufacturer's standard solvents complying with the following:

1. Acrylonitrile-Butadiene-Styrene (ABS): ASTM D 2235.
2. Chlorinated Poly(Vinyl Chloride) (CPVC): ASTM F 493.
3. Poly(Vinyl Chloride) (PVC): ASTM D 2564.
4. PVC to ABS Transition: Made to requirements of ASTM D 3138, color other than orange.

I. Plastic Pipe Seals: ASTM F 477, elastomeric gasket.

J. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon steel bolts and nuts.

K. Couplings: Iron body sleeve assembly, fabricated to match outside diameters of plain-end pressure pipes.

1. Sleeve: ASTM A 126, Class B, gray iron.
2. Followers: ASTM A 47, Grade 32510 or ASTM A 536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel paint.

2.3 PIPING SPECIALTIES

A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type where required to conceal protruding fittings and sleeves.

1. Inside Diameter: Closely fit around pipe, tube, and insulation.
2. Outside Diameter: Completely cover opening.
3. Cast Brass: One-piece, with set-screw.

    a. Finish: Rough brass.
    b. Finish: Polished chrome plate.

4. Cast Brass: Split casting, with concealed hinge and set-screw.

    a. Finish: Rough brass.
    b. Finish: Polished chrome plate.

5. Stamped Steel: One-piece, with set-screw and chrome-plated finish.
6. Stamped Steel: One-piece, with spring clips and chrome-plated finish.
7. Stamped Steel: Split plate, with concealed hinge, set-screw, and chrome-plated finish.
8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
9. Stamped Steel: Split plate, with exposed-rivet hinge, set-screw, and chrome-plated finish.
10. Stamped Steel: Split plate, with exposed-rivet hinge, spring clips, and chrome-plated finish.
11. Cast-Iron Floor Plate: One-piece casting.

B. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.

3. Dielectric Unions: Factory-fabricated, union assembly for 250-psig minimum working pressure at a 180 deg F temperature.

4. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150- or 300-psig minimum pressure to suit system pressures.
5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

    a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.

6. Dielectric Couplings: Galvanized-steel coupling, having inert and noncorrosive, thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 deg F temperature.
7. Dielectric Nipples: Electroplated steel nipple, having inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig working pressure at 225 deg F temperature.

C. Mechanical Sleeve Seals: Modular, watertight mechanical type. Components include interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connecting bolts and pressure plates cause rubber sealing elements to expand when tightened.

D. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:

1. Steel Sheet-Metal: 24-gage or heavier galvanized sheet metal, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.

3. Cast-Iron: Cast or fabricated wall pipe equivalent to ductile-iron pressure pipe, having plain ends and integral water stop, except where other features are specified.

4. Wall Penetration Systems: Wall sleeve assembly, consisting of housing, gaskets, and pipe sleeve, with 1 mechanical-joint end conforming to AWWA C110 and 1 plain pipe-sleeve end.

    a. Penetrating Pipe Deflection: 5 percent without leakage.
    b. Housing: Ductile-iron casting having waterstop and anchor ring, with ductile-iron gland, steel studs and nuts, and rubber gasket conforming to AWWA C111, of housing and gasket size as required to fit penetrating pipe.
    c. Pipe Sleeve: AWWA C151, ductile-iron pipe.
    d. Housing-to-Sleeve Gasket: Rubber or neoprene push-on type of manufacturer's design.

5. Cast-Iron Sleeve Fittings: Commercially made sleeve having an integral clamping flange, with clamping ring, bolts, and nuts for membrane flashing.

    a. Underdeck Clamp: Clamping ring with set-screws.

6. PVC Plastic: Manufactured, permanent, with nailing flange for attaching to wooden forms.
7. PVC Plastic Pipe: ASTM D 1785, Schedule 40.
8. PE Plastic: Manufactured, reusable, tapered, cup-shaped, smooth outer surface, with nailing flange for attaching to wooden forms.

2.4 IDENTIFYING DEVICES AND LABELS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 15 Sections. Where more than one type is specified for listed application, selection is Installer's option, but provide single selection for each product category.

B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped, permanently fastened to equipment.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
2. Location: An accessible and visible location.

C. Stencils: Standard stencils, prepared for required applications with letter sizes conforming to recommendations of ASME A13.1 for piping and similar applications, but not less than 1-1/4-inch -high letters for ductwork and not less than 3/4-inch -high letters for access door signs and similar operational instructions.

1. Material: Fiberboard.
2. Material: Brass.
3. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
4. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ASME A13.1 for colors.

D. Snap-On Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid snap-on, color-coded pipe markers, conforming to ASME A13.1.

E. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, conforming to ASME A13.1.

F. Plastic Duct Markers: Manufacturer's standard laminated plastic, color coded duct markers. Conform to following color code:

1. Green: Cold air.
2. Yellow: Hot air.
3. Yellow/Green: Supply air.
4. Blue: Exhaust, outside, return, and mixed air.
5. For hazardous exhausts, use colors and designs recommended by ASME A13.1.
6. Nomenclature: Include following:

a. Direction of air flow.
b. Duct service (supply, return, exhaust, etc.).
c. Duct origin (from).
d. Duct destination (to).
e. Design cfm.

G. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated.

1. Fabricate in sizes required for message.
2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
3. Punch for mechanical fastening.

4. Thickness: 1/16 inch, except as otherwise indicated.
5. Thickness: 1/8 inch, except as otherwise indicated.
6. Thickness: 1/16 inch for units up to 20 square inches or 8 inches long; 1/8 inch for larger units.
7. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.

H. Plastic Equipment Markers: Laminated-plastic, color-coded equipment markers. Conform to following color code:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Yellow/Green: Combination cooling and heating equipment and components.
4. Brown: Energy reclamation equipment and components.
5. Blue: Equipment and components that do not meet any of the above criteria.
6. For hazardous equipment, use colors and designs recommended by ASME A13.1.
7. Nomenclature: Include following, matching terminology on schedules as closely as possible:

    a. Name and plan number.
    b. Equipment service.
    c. Design capacity.
    d. Other design parameters such as pressure drop, entering and leaving conditions, and rpm.

8. Size: Approximately 2-1/2 by 4 inches for control devices, dampers, and valves; and 4-1/2 by 6 inches for equipment.

I. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are indicated, provide identification that indicates individual system number as well as service such as "Boiler No. 3," "Air Supply No. 1H," or "Standpipe F12."

2.5 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory-packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS--COMMON REQUIREMENTS

A. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 15 specify piping installation requirements unique to the piping system.

B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.

C. Install piping at indicated slope.

D. Install components having pressure rating equal to or greater than system operating pressure.

E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

F. Install piping free of sags and bends.

G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.

H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

I. Install piping to allow application of insulation plus 1-inch clearance around insulation.

J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

K. Install fittings for changes in direction and branch connections.

L. Install couplings according to manufacturer's printed instructions.

M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:

1. Chrome-Plated Piping: Cast-brass, one-piece, with set-screw, and polished chrome-plated finish. Use split-casting escutcheons, where required, for existing piping.
2. Uninsulated Piping Wall Escutcheons: Cast-brass or stamped-steel, with set-screw.
3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
4. Insulated Piping: Cast-brass or stamped-steel, with concealed hinge, spring clips, and chrome-plated finish.
5. Piping in Utility Areas: Cast-brass or stamped-steel, with set-screw or spring clips.

N. Sleeves are not required for core drilled holes.

O. Permanent sleeves are not required for holes formed by PE plastic (removable) sleeves.

P. Install sleeves for pipes passing through concrete and masonry walls, concrete floor and roof slabs, and where indicated.

Q. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, concrete floor and roof slabs, and where indicated.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring where specified.

2. Build sleeves into new walls and slabs as work progresses.

3. Install large enough sleeves to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

    a. PVC Pipe Sleeves: For pipes smaller than 6 inches.
    b. Steel Pipe Sleeves: For pipes smaller than 6 inches.
    c. Steel Sheet-Metal Sleeves: For pipes 6 inches and larger that penetrate gypsum-board partitions.
    d. Cast-Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Flashing is specified in Division 7 Section "Flashing and Sheet Metal."

        1) Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.

4. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants specified in Division 7 Section "Joint Sealants."

R. Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.

1. Install steel pipe for sleeves smaller than 6 inches.
2. Install cast-iron wall pipes for sleeves 6 inches and larger.
3. Assemble and install mechanical seals according to manufacturer's printed instructions.

S. Below Grade, Exterior Wall, Pipe Penetrations: Install cast-iron wall pipes for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.

T. Below Grade, Exterior Wall, Pipe Penetrations: Install ductile-iron wall penetration system sleeves according to manufacturer's printed installation instructions.

U. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping sealant material. Firestopping materials are specified in Division 7 Section "Firestopping."

V. Verify final equipment locations for roughing in.

W. Refer to equipment specifications in other Sections for roughing-in requirements.

X. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping system Sections.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Construct joints according to AWS "Soldering Manual," Chapter 22 "The Soldering of Pipe and Tube."
4. Brazed Joints: Construct joints according to AWS "Brazing Manual" in the "Pipe and Tube" chapter.
5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:

a. 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.
b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
c. Align threads at point of assembly.
d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

6. Welded Joints: Construct joints according to AWS D10.12 "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe" using qualified processes and welding operators according to the "Quality Assurance" Article.
7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. 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.
8. Plastic Pipe and Fitting Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following standards:
   a. Comply with ASTM F 402 for safe handling of solvent-cement and primers.
   b. Acrylonitrile-Butadiene-Styrene (ABS): ASTM D 2235 and ASTM D 2661.
   c. Chlorinated Poly(Vinyl Chloride) (CPVC): ASTM D 2846 and ASTM F 493.
   d. Poly(Vinyl Chloride) (PVC) Pressure Application: ASTM D 2672.
   e. Poly(Vinyl Chloride) (PVC) Non-Pressure Application: ASTM D 2855.
   f. PVC to ABS (Non-Pressure) Transition: Procedure and solvent cement described in ASTM D 3138.

9. Plastic Pipe and Fitting Heat-Fusion Joints: Prepare pipe and fittings and join with heat-fusion equipment according to manufacturer's printed instructions.

   a. Plain-End Pipe and Fittings: Butt joining.
   b. Plain-End Pipe and Socket-Type Fittings: Socket joining.

Y. Piping Connections: Except as otherwise indicated, make piping connections as specified below.

1. Install unions in piping 2 inches and smaller adjacent to each valve and at final connection to each piece of equipment having a 2-inch or smaller threaded pipe connection.
2. Install flanges in piping 2-1/2 inches and larger adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
3. Dry Piping Systems (Gas, Compressed Air, and Vacuum): Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems (Water and Steam): Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.2 EQUIPMENT INSTALLATION--COMMON REQUIREMENTS

A. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Architect.

E. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

F. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

E. Install equipment giving right-of-way to piping systems installed at a required slope.

3.3 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Stenciled Markers: Complying with ASME A13.1.
2. Plastic markers, with application systems. Install on pipe insulation segment where required for hot noninsulated pipes.
3. Locate pipe markers wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums), and exposed exterior locations as follows:

a. Near each valve and control device.
b. Near each branch, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.
c. Near locations where pipes pass through walls, floors, ceilings, or enter inaccessible enclosures.
d. At access doors, manholes, and similar access points that permit view of concealed piping.
e. Near major equipment items and other points of origination and termination.
f. Spaced at a maximum of 50-foot intervals along each run. Reduce intervals to 25 feet in congested areas of piping and equipment.
g. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

B. Equipment: Install engraved plastic laminate sign or equipment marker on or near each major item of mechanical equipment.

1. Lettering Size: Minimum 1/4-inch -high lettering for name of unit where viewing distance is less than 2 feet, 1/2-inch -high for distances up to 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
2. Text of Signs: Provide text to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to name of identified unit.

B. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers; or provide stenciled signs and arrows, showing duct system service and direction of flow.

1. Location: In each space where ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 50 feet.

C. Adjusting: Relocate identifying devices which become visually blocked by work of this Division or other Divisions.

3.4 PAINTING AND FINISHING

A. Refer to Division 9 Section "Painting" for field painting requirements.

B. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.5 CONCRETE BASES

A. Construct concrete equipment bases of dimensions indicated, but not less than 4 inches larger than supported unit in both directions. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi, 28-day compressive strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."

3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.8 DEMOLITION

A. Disconnect, demolish, and remove work specified under Division 15 and as indicated.

B. Where pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

D. Abandoned Work: Cut and remove buried pipe abandoned in place, 2 inches beyond the face of adjacent construction. Cap and patch surface to match existing finish.

E. Removal: Remove indicated equipment from the Project site.

F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.9 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.

B. Repair cut surfaces to match adjacent surfaces.

3.10 GROUTING

A. Install nonmetallic nonshrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms for placement of grout, as required.

D. Avoid air entrapment when placing grout.

E. Place grout to completely fill equipment bases.

F. Place grout on concrete bases to provide a smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout according to manufacturer's printed instructions.

END OF SECTION 15050

SECTION 15100 - VALVES

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 general duty valves common to several mechanical piping systems.

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 each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.

C. Maintenance data for valves to include in the operation and maintenance manual specified in Division 1. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.4 QUALITY ASSURANCE

A. Single-Source Responsibility: Comply with the requirements specified in Division 1 Section "Materials and Equipment," under "Source Limitations" Paragraph.

B. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

C. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set globe and gate valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
B

1. Gate Valves:

    a. Crane Company; Valves and Fitting Division.
    b. Hammond Valve Corporation.
    c. Kitz Corp. of America.
    d. Lunkenheimer/Cincinnati Valve Co.
    e. Milwaukee Valve Company, Inc.
    f. NIBCO Inc.
    g. Powell: Wm. Powell Company (The).
    h. Red-White Valve Corp.
    i. Stockham Valves & Fittings, Inc.

2. Ball Valves:

    a. Conbraco Industries, Inc.; Apollo Division.
    b. Hammond Valve Corporation.
    c. Milwaukee Valve Company, Inc.
    d. NIBCO Inc.
    e. Stockham Valves & Fittings, Inc.
    f. Tyler Pipe.
    g. Victaulic Company of America.

3. Swing Check Valves:

    a. Cla-Val Co.
    b. Crane Company; Valves and Fitting Division.
    c. Hammond Valve Corporation.
    d. Kitz Corp. of America.
    e. Lunkenheimer/Cincinnati Valve Co.
    f. Milwaukee Valve Company, Inc.
    g. NIBCO Inc.
    h. Powell: Wm. Powell Company (The).
    i. Red-White Valve Corp.
    j. Stockham Valves & Fittings, Inc.
    k. Victaulic Company of America.

2.2 BASIC, COMMON FEATURES

A. Design: Rising stem or rising outside screw and yoke stems, except as specified below.

1. Nonrising stem valves may be used only where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators: Use specified operators and handwheels, except provide the following special operator features:

1. Handwheels: For valves other than quarter turn.
2. Lever Handles: For quarter-turn valves 6 inches and smaller, except for plug valves, which shall have square heads. Furnish Owner with 1 wrench for every 10 plug valves.
3. Chain-Wheel Operators: For valves 4 inches and larger, installed 96 inches or higher above finished floor elevation.
4. Gear-Drive Operators: For quarter-turn valves 8 inches 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. Threads: ASME B1.20.1.

H. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

I. Solder Joint: ASME B16.18.

1. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

2.3 GATE VALVES

A. Gate Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi cold working pressure (CWP), or Class 150, 300-psi CWP; ASTM B 62 cast-bronze body and bonnet, solid-bronze wedge, copper-silicon alloy rising stem, teflon-impregnated packing with bronze packing nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

B. Gate Valves, 3 Inches and Larger: MSS SP-70, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bonnet, solid cast-iron wedge, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with 2-piece packing gland assembly, flanged end connections; and with cast-iron handwheel.

2.4 BALL VALVES

A. Ball Valves, 4 Inches and Smaller: MSS SP-110, Class 150, 600-psi CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; chrome-plated brass ball, standard port for 1/2-inch valves and smaller and conventional port for 3/4-inch valves and larger; blowout proof; bronze or brass stem; teflon seats and seals; threaded or soldered end connections:

1. Operator: Steel handwheel.
2. Stem Extension: For valves installed in insulated piping.
3. Memory Stop: For operator handles.

2.5 CHECK VALVES

A. Swing Check Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections:

B. Swing Check Valves, 3 Inches and Larger: MSS SP-71, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. 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.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the center of the pipe.

F. Install valves in a position to allow full stem movement.

G. For chain-wheel operators, extend chains to 60 inches above finished floor elevation.

H. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.

3.3 SOLDERED 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.

B. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Open gate and globe valves to fully 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 melts on 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 VALVE END SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2-1/2 Inches and Smaller: Solder ends, except provide threaded ends for heating hot water and low-pressure steam service.
2. Steel Pipe Sizes, 2-1/2 Inches and Smaller: Threaded or grooved end.
3. Steel Pipe Sizes, 3 Inches and Larger: Grooved end or flanged.

3.7 APPLICATION SCHEDULE

A. General Application: Use gate, ball, and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.

B. Domestic Water Systems: Use the following valve types:

1. Gate Valves: Class 125, bronze or cast-iron body to suit piping system.
2. Ball Valves: Class 150, 600-psi CWP, with stem extension.
3. Plug Valves: Neoprene-faced plug, Buna N packing.
4. Globe Valves: Class 125, bronze or cast-iron body to suit piping system, and bronze or teflon disc.
5. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze, or elastomer-coated ductile iron disc; EPDM or Buna N sleeve and stem seals.
6. Bronze Swing Check: Class 125, with rubber seat.
7. Check Valves: Class 125, swing or wafer type as indicated.

C. Heating Water Systems: Use the following valve types:

1. Gate Valves: Class 150, bronze or cast-iron body to suit piping system.
2. Ball Valves: Class 150, 600-psi CWP, with stem extension and memory stop.
3. Plug Valves: Viton or teflon packing.
4. Globe Valves: Class 150, bronze or cast-iron body to suit piping system, and bronze disc.
5. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze, or epoxy-coated ductile iron disc; EPDM or Buna N sleeve and stem seals.
6. Bronze Swing Check: Class 150, with composition seat.
7. Check Valves: Iron swing, wafer, or lift type, as indicated. Swing check shall be Class 150 with bronze seat ring.

3.8 ADJUSTING

A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION 15100

SECTION 15145 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes hangers and supports for mechanical systems piping and equipment.

1.3 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

1.4 PERFORMANCE REQUIREMENTS

A. Design seismic restraint hangers and supports, for piping and equipment.

B. Design and obtain approval from authority with jurisdiction over seismic restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each type of hanger and support.

C. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.

D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

E. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.

F. Licensed Engineer's hanger and support drawings specified in the "Quality Assurance" Article.

G. Licensed Engineer's hanger and support installation report specified in the "Field Quality Control" Article.

1.6 QUALITY ASSURANCE

A. Qualify welding processes and welding operators according to 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 according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

C. NFPA Compliance: Comply with NFPA 13 for hangers and supports used as components of fire protection systems.

D. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.

1. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

E. Licensed Operators: Use operators that are licensed by powder-operated tool manufacturers to operate their tools and fasteners.

F. Licensed Engineer: Prepare hanger and support design drawings, and calculations for seismic restraint of piping and equipment. Include seal and signature of Registered Engineer, licensed in jurisdiction where Project is located, certifying compliance with specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Hangers, Supports, and Components: Factory-fabricated according to MSS SP-58.

1. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.
2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Thermal-Hanger Shield Inserts: 100-psi average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.

C. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

D. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

2.2 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36, steel plates, shapes, and bars, black and galvanized.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Grout: ASTM C 1107, Grade B, nonshrink, nonmetallic.

1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is nonstaining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Water: Potable.
4. Packaging: Premixed and factory-packaged.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger requirements are specified in the Section specifying the equipment and systems.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.

3.2 HANGER AND SUPPORT INSTALLATION

A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.

C. Install supports with maximum spacings complying with MSS SP-69.

D. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

E. 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. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.

F. Install concrete inserts in new construction prior to placing concrete.

G. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

H. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

K. Support fire protection systems piping independent of other piping.

L. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

M. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

N. 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" is not exceeded.

O. Insulated Piping: Comply with the following installation requirements.

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 MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees and have dimensions in inches not less than the following:

NPS (Inches)	LENGTH (Inches)	THICKNESS (Inches)
1/4 to 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 to 14	24	0.075
16 to 24	24	0.105

4. Pipes 8 Inches and Larger: Include wood inserts.
5. Insert Material: Length at least as long as the protective shield.
6. Thermal-Hanger Shields: Install with insulation of same thickness as piping.

3.3 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 equipment, and make a smooth bearing surface.

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.

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 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, 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.
4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

A. Touching Up: Clean field welds and abraded areas of shop paint and paint exposed areas immediately after erection of hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal is specified in Division 9 Section "Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 FIELD QUALITY CONTROL

A. Licensed Engineer's Report: Prepare hanger and support installation report. Include seal and signature of Registered Engineer, licensed in jurisdiction where Project is located, certifying compliance with specifications.

END OF SECTION 15145

SECTION 15241 - MECHANICAL VIBRATION CONTROLS AND SEISMIC RESTRAINTS

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 vibration isolators, vibration isolation bases, vibration isolation roof curbs, and seismic restraints and snubbers.

1.3 SUBMITTALS

A. Product Data: Indicate types, styles, materials, and finishes for each type of isolator specified. Include load deflection curves.

B. Shop Drawings: Show designs and calculations, certified by a professional engineer, for the following:

1. Design Calculations: Calculations for selection of vibration isolators, design of vibration isolation bases, and selection of seismic restraints.
2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.
3. Seismic Restraint Details: Detail fabrication and attachment of restraints and snubbers.

1.4 QUALITY ASSURANCE

A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases and seismic restraints that are similar to those indicated for this Project in material, design, and extent.

1.5 PROJECT CONDITIONS

A. Project seismic zone is 4 with a zone factor of 0.40.

B. Building Importance Factor: 1.5.

1.6 COORDINATION

A. Coordinate layout and installation of vibration isolation and seismic-restraint devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of concrete housekeeping and vibration isolation bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Sections.

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. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. Apex Molded Products Co.
4. B-Line Systems, Inc.
5. Bramec Corp.
6. California Dynamics Corp.
7. Cannon Fabrication, Inc.
8. Diversitech Corp.
9. Fabreeka International, Inc.
10. GMT International Corp.
11. Greene Rubber Co.
12. Isolation Technology, Inc.
13. Karman Rubber.
14. Kinetics Noise Control, Inc.
15. King, H.A., Ltd.
16. Lord Industrial Products.
17. Mason Industries, Inc.
18. Metalastik, Inc.
19. Minor Rubber Co., Inc.
20. Rubatex Corp.
21. Service Rubber Group, Inc.
22. Stock Drive Products.
23. Tech Products Corp.
24. Vibration Eliminator Co., Inc.
25. Vibration Isolation Co., Inc.
26. Wagner Products Corp.

2.2 VIBRATION ISOLATORS

A. Isolator Pads: Oil and water resistant and factory cut to sizes that match requirements of the equipment supported.

1. Rubber Isolator Pads: Elastomer (neoprene or silicone) arranged in single or multiple layers and molded with a nonslip pattern and steel baseplates of sufficient stiffness to provide uniform loading over the pad area.
2. Fiberglass or Cork Isolator Pads: Molded cork or glass fiber not less than 1 inch thick and precompressed through 10 compression cycles at 3 times the rated load.
3. Load Range: From 10 to 50 psig and a deflection not less than 0.08 inch per 1 inch of thickness. Do not exceed a loading of 50 psig.

B. Rubber Isolator Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements, with encapsulated top- and baseplates. Factory-drilled and tapped top plate for bolted equipment mounting. Factory-drilled baseplate for bolted connection to structure. Color-code to indicate capacity range.

C. Spring Isolators: Freestanding, laterally stable, open-spring-type isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 1.2 times the rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to a 1/4-inch-thick, rubber isolator pad attached to the baseplate underside. Size baseplates to limit floor loading to 100 psig.
6. Top Plates: Provide threaded studs for fastening and leveling equipment.
7. Finishes: Manufacturer's standard corrosive-resistant finish.

D. Restrained Spring Isolators: Vertically restrained, freestanding, laterally stable, steel open-spring-type isolators.

1. Housing: Welded steel with resilient vertical limit stops to prevent spring extension due to wind loads or when weight is removed. Factory-drilled baseplate for bolting to structure and bonded to a 1/4-inch-thick, rubber isolator pad attached to the baseplate underside. Provide adjustable equipment mounting and leveling bolt.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 0.8 times the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Finishes: Baked enamel for metal components on isolators for interior use. Hot-dip galvanized for metal components on isolators for exterior use.

E. Rubber Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to formed-steel housings with threaded connections for hanger rods. Color-code to indicate capacity range.

F. Spring Hangers: Combination spring and elastomeric hanger with coil spring and elastomeric insert in compression.

1. Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
5. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

2.3 SEISMIC CONTROLS

A. Thrust Restraints: Combination spring and elastomeric restraints with coil spring and elastomeric insert in compression. Factory set for thrust.

1. Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
5. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

B. Manufactured Seismic Snubbers: All-directional, double-acting snubbers.

1. Construction: Interlocking steel members restrained by a 3/4-inch-thick, replaceable, shock-absorbing neoprene insert. Maintain 1/8-inch clearance in all directions between rigid and resilient surfaces.

C. Fabricated Seismic Snubbers: Welded structural-steel shapes designed and fabricated to restrain equipment or vibration isolation bases from excessive movement during a seismic event. Design to resist gravity forces identified by authorities having jurisdiction.

1. Construction: Welded steel shapes conforming to ASTM A 36.
2. Resilient Components: 3/4-inch-thick, replaceable, shock-absorbing neoprene insert.

2.4 VIBRATION ISOLATION BASES

A. Fabricated Steel Bases: Structural-steel bases and rails designed and fabricated by the isolation equipment manufacturer. Include equipment static loadings, power transmission, component misalignment, and cantilever loadings.

1. Fabricate bases to shapes required, with welded structural-steel shapes, plates, and bars conforming to ASTM A 36. Include support brackets to anchor base to isolation units. Include prelocated equipment anchor bolts and auxiliary motor slide bases or rails.
2. Design and fabricate bases to result in the lowest possible mounting height with not less than 1-inch clearance above the floor.
3. Concrete-Filled Inertia Bases: Weld reinforcing bars to the structural frame. Pour concrete into base with relocated equipment anchor bolts.
4. Weld steel angles on frame for outrigger isolation mountings, and provide for anchor bolts and equipment support.
5. Configure inertia bases to accommodate equipment supported.
6. Pump Bases: Size to support pump and piping elbows.
7. Factory Finish: Manufacturer's standard corrosive-resistant finish.

2.5 VIBRATION ISOLATION ROOF CURBS

A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb designed to resiliently support roof-mounted equipment and to withstand 125-mph wind impinging laterally against the side of the equipment. Design restraints to meet seismic requirements of authorities having jurisdiction.

B. Components: Upper support frame; lower support assembly; freestanding, unhoused, laterally stable steel springs; vertical and horizontal restraints.

1. Lower Support Assembly: Provide a means of attachment to the building structure and include a wood nailer stripe for attachment of roof material and 2 inches of rigid insulation on the inside of the assembly.

2. Spring Isolators: As indicated or scheduled. Include adjustment bolt to permit leveling of equipment after installation. Attach to lower assembly with a rubber isolation pad. Locate spring isolators so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
3. Water Seal: Elastomeric seal conforming to UL Class A roofing materials, attached to the upper support frame, extending down past the wood nailer of the lower support assembly, and counterflashed over the roof materials.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and anchor vibration-, sound-, and seismic-control products according to manufacturer's written instructions and authorities having jurisdiction.

B. Anchor interior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural floors as required by authorities having jurisdiction.

C. Anchor exterior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural supports as required by authorities having jurisdiction.

D. Fill concrete inertia bases, after installing base frame, with 3000-psig concrete, and trowel to a smooth, hard finish. Cast-in-place concrete is specified in Division 3.

E. Install pipe connectors at connections for equipment supported on vibration isolators.

3.2 SEISMIC CONTROL

A. Vibration Isolation Bases: Mount equipment on structural-steel bases or concrete inertia bases.

B. Snubbers: Install the required number of seismic snubbers on each spring-mounted piece of equipment. Locate snubbers as close as possible to the vibration isolators and bolt to supporting structure.

3.3 ADJUSTING AND CLEANING

A. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operations.

B. Adjust thrust restraints for a maximum of 1/4 inch of movement at start and stop.

END OF SECTION 15241

SECTION 15530 - REFRIGERANT PIPING

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 refrigerant piping used for air-conditioning applications, including pipes, tubing, fittings, and specialties; special-duty valves; and refrigerants.

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 each valve type and refrigerant piping specialty specified.

C. Shop Drawings showing layout of refrigerant piping, specialties, and fittings, including pipe and tube sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and equipment.

1. Refrigerant piping indicated is schematic only. Size and design the layout and installation of the piping, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and conformance with warranties of connected equipment.

D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience.

E. Maintenance data for refrigerant valves and piping specialties to include in the operation and maintenance manual specified in Division 1 Sections and Division 15 Section "Basic Mechanical Requirements."

1.4 QUALITY ASSURANCE

A. ASME Compliance: Qualify brazing and welding processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

B. Regulatory Requirements: Comply with provisions of the following codes:

1. ASME B31.5, "Refrigeration Piping."
2. ASHRAE 15, "Safety Code for Mechanical Refrigeration."

C. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."

D. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate the installation of roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Refrigeration Oil Test Kits: 2 each, containing everything required to conduct 1 test.
2. Refrigerant: 2 containers each, with 20 lb of refrigerant.
3. Filter-Dryer Cartridges: 3 of each type.

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. Refrigerants:

a. Allied Signal Inc.; Genetron Refrigerants.
b. DuPont Company; Fluorochemicals Div.
c. Elf Atochem North America, Inc.
d. ICI Americas Inc.; Fluorochemicals Bus.

2. Refrigerant Valves and Specialties:

a. Danfoss Electronics, Inc.
b. Eaton Corporation; Industrial Control Div.
c. Emerson Electric Company; Alco Controls Div.
d. Henry Valve Company.
e. Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
f. Sporlan Valve Company.

2.2 PIPES AND TUBES

A. Soft Copper Tube: ASTM B 88, Type L, annealed temper.

2.3 PIPE AND TUBE FITTINGS

A. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.

2.4 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (Silver).

B. Welding Materials: Comply with ASME Boiler and Pressure Vessel Code Section II, Part C, for welding materials appropriate for pipe being welded.

2.5 VALVES

A. Diaphragm Packless Valves: 500-psig working pressure and 275 deg F working temperature, globe or angle pattern, forged-brass or bronze body and bonnet, phosphor bronze and stainless-steel diaphragms, rising stem and handwheel, stainless-steel spring, nylon seat disc, with solder-end connections.

B. Packed-Angle Valves: 500-psig working pressure and 275 deg F working temperature, forged-brass or bronze body, forged-brass seal caps with copper gasket, back seating, rising stem and seat, molded stem packing, with solder-end connections.

C. Check Valves--Smaller than 1-Inch NPS: 500-psig operating pressure, 300 deg F operating temperature; cast-brass body, with removable piston, PTFE seat, and stainless-steel spring; straight-through globe design. Valve shall be straight-through pattern, with solder-end connections.

D. Check Valves--Larger than 1-Inch NPS: 450-psig operating pressure, 300 deg F operating temperature; cast-bronze body, with cast-bronze or forged-brass bolted bonnet; floating piston with mechanically retained PTFE seat disc. Valve shall be straight-through or angle pattern, with solder-end connections.

E. Service Valves: 500-psig pressure rating, forged-brass body with copper stubs, brass caps, removable valve core, integral ball check valve, with solder-end connections.

F. Solenoid Valves: Conform to ARI 760; 250 deg F temperature rating, 400-psig working pressure; forged brass, with PTFE valve seat, 2-way straight-through pattern, and solder-end connections; manual operator; with NEMA 250, Type 1 solenoid enclosure with 1/2-inch conduit adapter, and 24-V normally closed holding coil.

G. Pressure Relief Valves: Straight or angle brass body and disc, neoprene seat, factory sealed and ASME labeled, for standard pressure setting.

H. Thermal Expansion Valves: Conform to ARI 750; thermostatic-adjustable, modulating type; size as required and factory set for superheat requirements; solder-end connections; with sensing bulb, distributor having side connection for hot-gas bypass line, and external equalizer line.

2.6 REFRIGERANT PIPING SPECIALTIES

A. Straight- or Angle-Type Strainers: 430-psig working pressure; forged-brass or steel body with stainless-steel wire or brass-reinforced Monel screen, and screwed cleanout plug, with solder-end connections.

B. Moisture/Liquid Indicators: 500-psig operating pressure, 200 deg F operating temperature; forged-brass body, with replaceable, polished, optical viewing window with color-coded moisture indicator, and solder-end connections.

C. Permanent Filter-Dryer: 350-psig maximum operating pressure, 225 deg F maximum operating temperature; steel shell, and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.

D. Flexible Connectors: 500-psig operating pressure; seamless tin-bronze or stainless-steel core, high-tensile bronze-braid covering, solder-end connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inches long.

2.7 REFRIGERANT

A. ASHRAE 34, R-22: Monochlorodifluoromethane.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for compliance with requirements for installation tolerances and other conditions affecting performance of refrigerant piping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Aboveground, within Building: Type L drawn-copper tubing.

B. Belowground for 2-Inch NPS and Smaller: Type L annealed-copper tubing.

C. Belowground for Larger than 2-Inch NPS: Type K annealed-copper tubing.

3.3 INSTALLATION

A. Install refrigerant piping according to ASHRAE 15.

B. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

C. Install piping in short and direct arrangement, with minimum number of joints, elbows, and fittings.

D. Arrange piping to allow normal inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.

E. Install piping with adequate clearance between pipe and adjacent walls and hangers, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

F. Belowground, install copper tubing in conduit. Vent conduit outdoors.

G. Insulate suction lines and liquid lines, but insulate them together if adjacent.

1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

H. Install branch lines to parallel compressors of equal length, and pipe identically and symmetrically.

I. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

J. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope of 0.4 percent downward away from compressor.
2. Install horizontal suction lines with a uniform slope of 0.4 percent downward to compressor.
3. Install traps and double risers where indicated and where required to entrain oil in vertical runs.
4. Liquid lines may be installed level.

K. Use fittings for changes in direction and branch connections.

L. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

M. Reduce pipe sizes using eccentric reducer fittings installed with level side down.

N. Provide bypass around moisture-liquid indicators in lines larger than 2-inch NPS.

O. Install unions to allow removal of solenoid valves, pressure-regulating valves, expansion valves, and at connections to compressors and evaporators.

P. Install flexible connectors at the inlet and discharge connection, at right angles to axial movement of compressor, parallel to crankshaft.

Q. Install replaceable-core filter-dryers, with isolation valves and valved bypass.

R. Install refrigerant valves according to manufacturer's written instructions.

S. When brazing, remove solenoid-valve coils; remove sight glasses; and remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties. Do not apply heat near bulb of expansion valve.

T. Electrical wiring for solenoid valves is specified in Division 16 Sections. Coordinate electrical requirements and connections.

U. Mount thermostatic expansion valves in any position, close to evaporator.

1. Where refrigerant distributors are used, mount directly on expansion-valve outlet.
2. Install valve so diaphragm case is warmer than bulb.
3. Secure bulb to clean, straight, horizontal section of suction line using 2 bulb straps. Do not mount bulb in a trap or at the bottom of the line.
4. Where external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

V. Install pressure relief valves as required by ASHRAE 15. Pipe pressure relief valves on receivers to outdoors.

W. Charge and purge systems, after testing, and dispose of refrigerant following ASHRAE 15 procedures.

X. Charge system as follows:

1. Install filter-dryer core after leak test, but before evacuation.
2. Evacuate refrigerant system with vacuum pump, until temperature of 35 deg F is indicated on vacuum dehydration indicator.
3. Maintain vacuum for a minimum of 5 hours.
4. Break vacuum with refrigerant gas and charge to 2 psig.

3.4 HANGERS AND SUPPORTS

A. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.

B. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.

C. Pipe rollers for multiple horizontal runs, 20 feet or longer supported by a trapeze.

D. Spring hangers to support vertical runs.

E. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes. Tube sizes are nominal or standard tube sizes as expressed in ASTM B 88.

1. 1/2 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. 5/8 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. 1 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
4. 1-1/4 Inches: Maximum span, 72 inches; minimum rod size, 1/4 inch.
5. 1-1/2 Inches: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. 2 Inches: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. 2-1/2 Inches: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. 3 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
9. 4 Inches: Maximum span, 12 feet; minimum rod size, 1/2 inch.

F. Support vertical runs at each floor.

3.5 PIPE JOINT CONSTRUCTION

A. Basic pipe and tube joint construction is specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent formation of scale.

3.6 VALVE INSTALLATIONS

A. Install refrigerant valves according to manufacturer's written instructions.

B. Install valves on suction and discharge of compressor, for gage taps at compressor inlet and outlet, for gage taps at hot-gas bypass regulators, on inlet and outlet, and on each side of strainers.

C. Install check valves on compressor discharge and on condenser liquid lines on multiple condenser systems.

D. Install refrigerant-charging (packed-angle) valve in liquid line between receiver shutoff valve and expansion valve.

E. Install globe valves on each side of strainers and dryers, in liquid and suction lines at evaporators, and elsewhere as indicated.

F. Install a full-sized, 3-valve bypass around each dryer.

G. Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

1. Electrical wiring for solenoid valves is specified in Division 16 Sections. Coordinate electrical requirements and connections.

H. Mount thermostatic expansion valves in any position, close to evaporator.

1. Where refrigerant distributors are used, mount directly on expansion-valve outlet.
2. Install valve so diaphragm case is warmer than bulb.
3. Secure bulb to clean, straight, horizontal section of suction line using 2 bulb straps. Do not mount bulb in a trap or at the bottom of the line.
4. Where external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

I. Install pressure-regulating and relief valves as required by ASHRAE 15.

3.7 SPECIALTIES APPLICATION AND INSTALLATION

A. Install liquid indicators in liquid line leaving condenser, in liquid line leaving receiver, and on leaving side of liquid solenoid valves.

B. Install strainers immediately upstream of each automatic valve, including expansion valves, solenoid valves, hot-gas bypass valves, and compressor suction valves.

C. Install strainers on main liquid line where multiple expansion valves with integral strainers are used.

D. Install strainers in suction line of steel pipe.

E. Install moisture-liquid indicators in liquid lines between filter-dryers and thermostatic expansion valves and in liquid line to receiver.

F. Install pressure relief valves on ASME receivers, and pipe to outdoors.

G. Install replaceable-core filter-dryers in vertical liquid line adjacent to receivers and before each solenoid valve.

H. Install permanent filter-dryers in low-temperature systems, in systems using hermetic compressors, and before each solenoid valve.

I. Install solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.

J. Install receivers on systems 5 tons and larger, and on systems with long piping runs, sized to accommodate pump-down charge.

K. Install flexible connectors at or near compressors where piping configuration does not absorb vibration.

3.8 CONNECTIONS

A. Electrical: Conform to applicable requirements of Division 16 Sections for electrical connections.

3.9 FIELD QUALITY CONTROL

A. Inspect and test refrigerant piping according to ASME B31.5, Chapter VI.

1. Pressure test with nitrogen to 200 psig. Perform final tests at 27-psig vacuum and 200 psig using halide torch or electronic leak detector. Test to no leakage.

B. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

C. Repair leaks using new materials; retest.

3.10 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

3.11 CLEANING

A. Before installation of copper tubing other than Type ACR, clean tubing and fittings with trichloroethylene.

3.12 COMMISSIONING

A. Charge system using the following procedures:

1. Install core in filter dryer after leak test, but before evacuation.
2. Evacuate refrigerant system with vacuum pump until temperature of 35 deg F is indicated on vacuum dehydration indicator.
3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
5. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
6. Complete charging of system, using new filter-dryer core in charging line. Provide full-operating charge.

END OF SECTION 15530

SECTION 15670 - CONDENSING UNITS

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. Division-15 Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 SUMMARY:

A. Section includes:

1. Residential air-cooled condensing units.
2. Air-cooled condensing units.

B. Related Sections:

1. Section 15530 - Refrigerant Piping

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights (shipping, installed, and operating), dimensions, required clearances, and methods of assembly of components, furnished specialties and accessories; and installation and start-up instructions.

B. Wiring Diagrams: Submit ladder-type wiring diagrams for power and control wiring required for final installation of condensing units and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

C. Operation and Maintenance Data: Submit maintenance data and parts list for each condensing unit, control, and accessory; including "trouble shooting" maintenance guide; plus servicing, and preventative maintenance procedures and schedule. Include this data and product data in maintenance manual; in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of condensing units, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. Capacity ratings for condensing units shall be in accordance with ARI Standard 360 "Standard for Commercial and Industrial Unitary Air-Conditioning Equipment".
2. Refrigeration system of condensing units shall be constructed in accordance with ASHRAE Standard ASHRAE 15 "Safety Code for Mechanical Refrigeration".

3. Condensing units shall meet or exceed the minimum COP/Efficiency levels as prescribed in ASHRAE 90A "Energy Conservation in New Building Design".
4. Construction and testing of water cooled condensing units shall be in accordance with ASME Boiler and Pressure Vessel Code, Section VIII.
5. Condensing units shall be listed by UL and have UL label affixed.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Handle condensing units and components carefully to prevent damage. Follow manufacturer's written instructions for rigging. Replace damaged condensing units or components.

B. Store condensing units and components in clean dry place off the ground. Protect from weather, water, and physical damage.

1.6 SPECIAL PROJECT WARRANTY:

A. Warranty on Motor/Compressor: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, motors/compressors with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

1. Warranty Period: 5 years from date of substantial completion.

PART 2 - PRODUCTS

2.1 RESIDENTIAL AIR-COOLED CONDENSING UNITS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering residential air-cooled condensing units which may be incorporated in the work include, but are not limited to, the following:

1. BDP Co; Div Carrier Corp.
2. Carrier Air Conditioning; Div Carrier Corp.
3. Fedders Air Conditioning USA; Fedders Corp.
4. Lennox Industries, Inc.
5. Trane (The) Co; Div American Standard Inc.
6. York; Div York International.

B. General: factory-assembled and tested air-cooled condensing units, consisting of compressor, condenser coil, fan, motor, refrigerant reservoir, and operating controls. Capacity and electrical characteristics are scheduled (on the Drawings) (at the end of this Section).

C. Casing: galvanized steel finished with baked enamel, complete with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Unit shall be complete with brass service valves, fittings, and gage ports on exterior of casing.

D. Compressor: hermetically sealed with built-in overloads and vibration isolation. Compressor motor, shall have thermal and current sensitive overload devices, internal high-pressure protection, high and low pressure cutout switches, start capacitor and relay, 2-pole contactor,

crankcase heater, and temperature actuated switch and timer to prevent compressor rapid cycle.

E. Condenser: coil shall have copper tubes and aluminum fins, or aluminum tubes and aluminum fins; complete with liquid accumulator and liquid subcooler. Aluminum propeller fan shall be direct driven, with permanently lubricated fan motor having thermal overload protection.

F. Accessories:

1. Low-voltage thermostat and subbase to control condensing unit and evaporator fan.
2. Precharged and insulated suction and liquid tubing of length indicated.
3. Head pressure control to modulate condenser fan motor speed for low ambient conditions.
4. Heat reclaim device providing preheating of domestic hot water with hot gas from condensing unit.
5. Low-voltage control transformer.
6. Water-to-refrigerant heat exchanger.

2.2 AIR-COOLED CONDENSING UNITS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering air-cooled condensing units which may be incorporated in the work include, but are not limited to, the following:

1. BDP Co; Div Carrier Corp.
2. Carrier Air Conditioning; Div of Carrier Corp.
3. McQuay Air Conditioning Group; McQuay Inc.
4. Trane (The) Co; Div American Standard Inc.
5. York; Div of York International.

B. General: factory-assembled and tested air-cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls. Capacities and electrical characteristics are scheduled (on the Drawings) (at the end of this Section).

C. Unit Casings: designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include:

1. steel, galvanized or zinc-coated, for exposed casing surfaces, treated and finished with manufacturer's standard paint coating;
2. lifting lugs to facilitate rigging of units;
3. factory-installed metal grilles, for protection of condenser coil during shipping, installation, and operation;
4. hinged and gasketed control panel door.

D. Compressor: reciprocating hermetic-type compressor, 1,750 RPM, designed for air-cooled condensing, complete with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports. Capacity shall be controlled through cylinder unloading. Additional features include:

1. Crankcase heater in well within crankcase;
2. Capacity steps as scheduled, or greater number;
3. Compressor of same manufacturer as condensing unit.

E. Controls: Operating and safety controls shall include high and low pressure cutouts, oil pressure cutout, compressor winding thermostat cutout, 3-leg compressor overload protection, and condenser fan motors with thermal and overload cutouts. Control transformer if required shall be 115-volts. Provide magnetic contactors for compressor and condenser fan motors. Additional features include:

1. Reset relay circuit for manual resetting of cutouts from remote thermostat location;
2. Automatic nonrecycling pumpdown, and timing device to prevent excessive compressor cycling;
3. Unfused disconnect switch, factory-mounted and wired, for single external electrical power connection.

F. Condensing Section: Condenser coil shall be seamless copper tubing mechanically bonded to heavy-duty, configurated aluminum fins, with separate and independent refrigeration circuit for each compressor. Units shall include liquid accumulator and subcooling circuit, and backseating liquid line service access valve. Condenser coils shall be factory-tested at 450 psig, vacuum dehydrate, and filled with a holding charge of nitrogen.

G. Condenser fans and drives: propeller-type condenser fans for vertical air discharge; either direct drive or belt drive. Additional features include:

1. Permanent lubricated ball bearing condenser fan motors;
2. Separate motor for each condenser fan;
3. Constant speed condenser fan motors;
4. Each fan assembly shall be dynamically and statically balanced.

H. Low ambient control: factory-installed low ambient damper assembly, fan speed control, or fan cycling control.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Verify roof structure, mounting supports, and membrane installations are completed to the proper point to allow installation of roof mounted units. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. General: Install condensing units in accordance with manufacturers installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Support:

C. Install ground-mounted units on 4 inches thick reinforced concrete pad, 4 inches larger on each side than condensing unit. Concrete is specified in Division 3. Coordinate installation of anchoring devices.

D. Install roof-mounted units on equipment supports specified in Division 7. Anchor unit to supports with removable fasteners.

E. Residential Units: Connect pre-charged refrigerant tubing to unit's quick-connect fittings. Run tubing so as not to interfere with access to unit.

1. Install furnished accessories.

F. Air-Cooled Condensing Units: Connect refrigerant piping to unit; maintain required access to unit.

1. Install furnished field-mounted accessories.

3.3 FIELD QUALITY CONTROL:

A. Testing:

B. Charge systems with refrigerant and oil, and test for leaks. Repair leaks and replace lost refrigerant and oil.

3.4 DEMONSTRATION:

A. Provide services of manufacturer's authorized service representative to provide start-up service and to instruct Owner's personnel in operation and maintenance of condensing units.

B. Start-up condensing units, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

C. Train Owner's personnel on start-up and shut-down procedures, troubleshooting procedures, servicing, and preventative maintenance schedule and procedures. Review with the Owner's personnel, the data contained in the Operating and Maintenance Manuals specified in Division One.

1. Schedule training with Owner, provide at least 7-day prior notice to Architect/Engineer.

END OF SECTION 15670

SECTION 15738 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.2 DEFINITIONS

A. Evaporator-Fan Unit: The part of the split-system air-conditioning unit that contains a coil for cooling (heat rejection for heating operation in heat pump units) and a fan to circulate air to conditioned space.

B. Compressor-Condenser Unit: The part of the split-system air-conditioning unit that contains a refrigerant compressor and a coil for condensing refrigerant (evaporator for heating operation in heat pump units).

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace split-system air-conditioning units that fail in materials and workmanship within five years from date of Substantial Completion.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set.

2. Filters: One set.

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. Carrier Air Conditioning; Div. of Carrier Corp.
2. Evcon Industries, Inc.
3. Friedrich Air Conditioning Company.
4. Koldwave.
5. Lennox Industries Inc.
6. Mitsubishi Electric Sales Canada, Inc.
7. Mitsubishi Electronics America, Inc.; HVAC Division.
8. Mitsubishi Heavy Industries America, Inc.; Air-Conditioning & Refrigeration Division, Inc.
9. Sanyo HVAC.
10. Tadiran Electronic Industries Inc.; Appliance Division.
11. Trane Co. (The); Unitary Products Group.
12. York International Corp.
13. Daikin

C. Split system shall have a SEER equal or greater than 12.0.

2.2 EVAPORATOR-FAN UNIT

A. Concealed Unit Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

1. Insulation: Faced, glass-fiber duct liner.
2. Drain Pans: Galvanized steel, with connection for drain; insulated.

B. Floor-Mounting, Unit Cabinet: Enameled steel with removable panels on front and ends.

1. Discharge Grille: Steel with surface-mounted frame or Welded steel bars forming a linear grille and welded into supporting panel.
2. Insulation: Faced, glass-fiber, duct liner.
3. Drain Pans: Galvanized steel, with connection for drain; insulated.Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Heating Coil: Copper-tube water coil, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm); leak tested to 300 psig (2070 kPa) underwater; and having a 2-position control valve.

D. Heating Coil: Helical, nickel-chrome, electric-resistance heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-

reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

E. Evaporator Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

F. Fan Motor: Multispeed, PSC type.

G. Disposable Filters: 1 inch (25 mm) thick, Permanent, cleanable.

H. Wiring Terminations: Connect motor to chassis wiring with plug connection.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER UNIT

A. Casing steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed reciprocating type with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).

H. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

B. Install ground-mounted, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base; 4 inches (100 mm) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

C. Install ground-mounted, compressor-condenser components on polyethylene mounting base.

D. Anchor units to supports with removable, cadmium-plated fasteners.

E. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch (25 mm).

3.2 CONNECTIONS

A. Connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

B. Install piping adjacent to unit to allow service and maintenance.

C. Unless otherwise indicated, connect piping with unions and shutoff valves to allow units to be disconnected without draining piping. Refer to piping system Sections for specific valve and specialty arrangements.

3.3 FIELD QUALITY CONTROL

A. Installation Inspection: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections, and to prepare a written report of inspection.

B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 15738

SECTION 15782 - ROOFTOP UNITS

PART 1 - GENERAL

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 SUMMARY

A. This Section includes rooftop heating and cooling units.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of checklists.

D. Maintenance Data: For equipment to include in the maintenance manuals specified in Division 1.

E. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Energy Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

E. Comply with AGA Z223.1 for gas-fired furnace section.

F. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver rooftop units as factory-assembled units with protective crating and covering.

B. Coordinate delivery of units in sufficient time to allow movement into building.

C. Handle rooftop units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

1.6 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations with roof construction. Roof specialties are specified in Division 7 Sections.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period, Compressors: Manufacturers standard, but not less than 5 years after date of Substantial Completion.
2. Warranty Period, Heat Exchangers: Manufacturers standard, but not less than 10 years after date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Fan Belts: One set for each belt-drive fan.
2. Filters: One set of filters for each unit.

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. Rooftop Units, 6 Tons and Smaller:

a. Carrier Corp.; Carrier Air Conditioning Div.
b. Lennox Industries Inc.

c. McQuay International.
d. Trane Company (The); North American Commercial Group.
e. York International Corp.

2. Rooftop Units, 7-1/2 to 20 Tons:

a. Carrier Corp.; Carrier Air Conditioning Div.
b. Engineered Air.
c. Lennox Industries Inc.
d. McQuay International.
e. Trane Company (The); North American Commercial Group.
f. York International Corp.

3. Rooftop Units, 20 Tons and Larger:

a. Carrier Corp.; Carrier Air Conditioning Div.
b. Engineered Air.
c. Lennox Industries Inc.
d. McQuay International.
e. Trane Company (The); North American Commercial Group.
f. York International Corp.

2.2 ROOFTOP UNITS SMALLER THAN 6 TONS

A. Description: Factory assembled and tested; designed for roof or slab installation; and consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration and temperature controls, filters, and dampers.

B. Casing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, removable panels or access doors with neoprene gaskets for inspection and access to internal parts, minimum 1/2-inch-thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.

C. Evaporator Fans: Forward curved, centrifugal, directly driven with permanently lubricated motor bearings.

D. Condenser Fans: Propeller type, directly driven with permanently lubricated motor bearings.

E. Refrigerant Coils: Aluminum-plate fin and seamless copper tube in galvanized steel casing with equalizing-type vertical distributor.

F. Compressors: Hermetic with integral vibration isolators and crankcase heaters.

G. Economizer Control: Return- and outside-air dampers, outside-air filter, fully modulating electronic-control system with adjustable mixed-air thermostat and automatic changeover.

H. Thermostat: Programmable, electronic; with heating setback and cooling setup with 7-day programming.

2.3 ROOFTOP UNITS, 7-1/2 TO 20 TONS

A. Description: Factory assembled and tested; designed for roof or slab installation; and consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration and temperature controls, filters, and dampers.

B. Casing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, removable panels or access doors with neoprene gaskets for inspection and access to

internal parts, minimum 1/2-inch-thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.

C. Evaporator Fans: Forward curved, centrifugal, belt driven with adjustable sheaves or direct-drive fans; and with permanently lubricated motor bearings.

D. Exhaust/Relief Fans: Forward-curved, centrifugal or propeller type, directly driven with permanently lubricated motor bearings.

E. Condenser Fans: Propeller type, directly driven with permanently lubricated motor bearings.

F. Refrigerant Coils: Aluminum-plate fin and seamless copper tube in galvanized steel casing with equalizing-type vertical distributor.

G. Compressors: Serviceable, semihermetic, or fully hermetic compressors with integral vibration isolators and crankcase heaters.

1. Safety Controls: Manual-reset type for low pressure, high pressure, and compressor motor overload protection.
2. Hot-Gas Bypass: Factory-installed valve.
3. Timed-Off Control: Automatic-reset control shuts compressor off after 5 minutes.

H. Economizer Control: Return- and outside-air dampers, outside-air filter, fully modulating electronic-control system with adjustable mixed-air thermostat and automatic changeover through adjustable enthalpy-control device.

I. Thermostat: Programmable, electronic; with heating setback and cooling setup with 7-day programming.

J. Smoke Detectors: Photoelectric detector located in return-air plenum, to de-energize unit.

K. Operating Controls: Factory-installed microprocessor controls and monitors unit and communicates with central control processor.

1. Control Outputs: 2-stage heating, 2-stage cooling; and automatic or continuous fan operation and economizer damper operation.
2. Control Sensors: Return-air-temperature sensor, fan airflow-proving switch, dirty-filter switch, discharge-air-temperature sensor, room-temperature sensor, and night-setback-override switch.
3. Control Features: Day/occupied modes for high or low enthalpy and night/unoccupied mode.

2.4 ROOFTOP UNITS LARGER THAN 20 TONS

A. Description: Factory assembled and tested; designed for roof or slab installation; and consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration and temperature controls, filters, and dampers.

B. Casing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, removable panels or access doors with neoprene gaskets, minimum 1/2-inch-thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.

C. Evaporator Fans: Forward curved, centrifugal, belt driven with adjustable sheaves and permanently lubricated motor bearings.

D. Condenser Fans: Propeller type, directly driven with permanently lubricated motor bearings.

E. Filters: 2-inch-thick, fiberglass, throwaway filters in filter rack.

F. Refrigerant Coils: Aluminum-plate fin and seamless copper tube in galvanized steel casing with equalizing-type vertical distributor and thermal expansion valve; tested to 450 psig and leak tested to 300 psig with air under water. Insulate coil section.

G. Compressors: Semihermetic or hermetic compressors with integral vibration isolators, and crankcase heaters that de-energize during compressor operation, with thermal expansion valves, filter-dryers, sight glasses, compressor service valves, and liquid- and suction-line service valves.

1. Refrigerant Circuits: Interlaced coil refrigerant circuiting with circuit for each compressor.
2. Capacity Control: Cylinder unloaders with steps as scheduled.
3. Capacity Control: Hot-gas bypass valve and piping on one compressor.
4. Low-Pressure Cutout: Manual reset.
5. High-Pressure Cutout: Manual reset.
6. Compressor Motor Overload Protection: Manual reset.
7. Antirecycling Timing Device: Prevents compressor restart for 5 minutes after shutdown.
8. Adjustable, Low Ambient Head-Pressure Control: Designed to operate at temperatures as low as 0 deg F, by cycling condenser fans and controlling speed of last fan of each circuit.
9. Oil-Pressure Switch: Designed to shut down compressors on low oil pressure.

H. Economizer Dampers: Return- and outside-air dampers with damper operator and control package.

1. Leakage: Maximum leakage 2.5 percent at nominal airflow of 400 cfm per ton with 1-inch wg pressure differential.
2. Damper Operator: 24 V, with gear train sealed in oil with spring return.

I. Economizer Control: Return- and outside-air dampers, outside-air filter, fully modulating electronic-control system with adjustable mixed-air thermostat and automatic changeover through adjustable enthalpy-control device.

J. Temperature Control: Factory-installed, demand-oriented, solid-state control system with minimum of 2 cooling steps and 2 heating steps, including solid-state room thermostat with dead band, and subbase with system and fan switches. Include the following:

1. Discharge-air-temperature reset with space-temperature override.
2. 7-day programmable clock, with power-failure carryover, for remote mounting.
3. Warm-up cycle.

K. Remote-Control Panel: Contains controls and indicator lights as follows:

1. Heat-cool-auto system switch.
2. On-off fan switch.
3. Minimum outside-air damper potentiometer position LCD.
4. Supply-fan operating indicator light.
5. Mechanical cooling malfunction indicator light.
6. Clogged filters indicator light.

L. Smoke Detectors: Photoelectric detector located in return-air plenum, to de-energize unit.

M. Electrical Convenience Outlet: 115-V, ac fused outlet, separately fused, located in unit cabinet or in roof curb perimeter.

AB. Operating Controls: Factory-installed microprocessor controls and monitors unit and communicates to central control processor.

1. Control Outputs: Heating, cooling; and automatic or continuous fan operation and economizer damper operation.
2. Return-air-, discharge-air-, outdoor-air-, space-, control set-point temperature LCD.
3. Outdoor enthalpy LCD.
4. Filter pressure drop LCD.
5. Status: Airflow, fans, system, unit operation, operating mode.
6. Inlet-vane and economizer-damper position LCD.
7. Duct static-pressure LCD.
8. Alarm LCD.
9. Control Features: Day/occupied and night/unoccupied modes, temperature reset.

2.5 ROOF CURBS

A. Manufacturer's standard, insulated with corrosion-protection coating, gasketing, factory-installed wood nailer, according to NRCA standards.

1. Curb Height: Minimum 16 inches.
2. Isolation Curb: Rigid upper and lower steel structure with vibration isolation springs and vertical and horizontal restraints; with elastomeric waterproof membrane. 2-inch static deflection.

2.6 MOTORS

A. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.

B. Enclosure Type: Open, dripproof.

2.7 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate capacity according to ARI 210/240, "Unitary Air-Conditioning and Air Source Heat Pump Equipment."

B. Verification of Performance: Rate capacity according to ARI 360, "Commercial and Industrial Unitary Air-Conditioning Equipment."

1. Sound Power Level Ratings: Comply with ARI 270, "Standard for Sound Rating of Outdoor Unitary Equipment."

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine roof for compliance with requirements for conditions affecting installation and performance of rooftop units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units according to manufacturer's written instructions.
B. Install units level and plumb, maintaining manufacturer's recommended clearances.

C. Curb Support: Install roof curb on roof structure, level, according to NRCA's written installation instructions. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing with roof construction.

D. Unit Support: Install unit on structural curbs and level. Coordinate wall penetrations and flashing with wall construction.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping to allow service and maintenance.

B. Duct installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination in roof mounting frames. Where indicated, terminate return-air duct through roof structure and insulate space between roof and bottom of unit.

C. Electrical: Conform to applicable requirements in Division 16 Sections.

D. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 COMMISSIONING

A. Verify that installation is as indicated and specified.

B. Complete manufacturer's installation and startup checks and perform the following:

1. Level unit on housekeeping base, and flash curbs to unit and to roof.
2. Inspect for visible damage to unit casing.
3. Inspect for visible damage to furnace combustion chamber.
4. Inspect for visible damage to compressor, air-cooled condenser coil, and fans.
5. Verify that clearances have been provided for servicing.
6. Check that labels are clearly visible.
7. Clean furnace flue and condenser and inspect for construction debris.
8. Verify that controls are connected and operable.
9. Remove shipping bolts, blocks, and tie-down straps.
10. Verify that filters are installed.
11. Adjust vibration isolators.
12. Connect and purge gas line.
13. Check that burner and controls are suitable to operate at temperatures as low as minus 40 deg F.
14. Check acoustic insulation.
15. Check operation of barometric dampers.

C. Lubricate bearings on fan.

D. Check fan-wheel rotation for correct direction without vibration and binding.

E. Adjust fan belts to proper alignment and tension.

F. Start unit according to manufacturer's written instructions.

1. Perform starting of refrigeration in summer only.
2. Complete startup sheets and attach copy with Contractor's startup report.

G. Check and record performance of interlocks and protection devices; verify sequences.

H. Operate unit for an initial period as recommended or required by manufacturer.

I. Calibrate thermostats.

J. Adjust and check high-temperature limits.

K. Check internal isolators.

L. Check outside-air damper for proper stroke and interlock with return-air dampers.

M. Check controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

N. Start refrigeration and measure and record the following:

1. Coil leaving-air, dry- and wet-bulb temperatures.
2. Coil entering-air, dry- and wet-bulb temperatures.
3. Outside-air, dry-bulb temperature.
4. Air-cooled-condenser, discharge-air, dry-bulb temperature.

O. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

1. Supply-air volume.
2. Return-air volume.
3. Outside-air intake volume.

P. Simulate maximum cooling demand and check the following:

1. Compressor refrigerant suction and hot-gas pressures.
2. Short circuiting air through condenser or from condenser to outside-air intake.

Q. Verify operation of remote panel, including pilot-light operation and failure modes. Check the following:

1. High-limit heat exchanger.
2. Warm-up for morning cycle.
3. Freezestat operation.
4. Free-cooling mode, outside-air changeover.
5. Alarms.

R. After starting and performance testing, change filters, vacuum heat exchanger and cooling and condenser coils, lubricate bearings, adjust belt tension, and check operation of power vents.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals. Refer to Division 1 Section "Contract Closeout."
3. Review data in the maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
4. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION 15782

SECTION 15840 - UNIT VENTILATORS

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 unit ventilators with the followingcooling elements:

1. Chilled-water cooling coil.
2. Refrigerant cooling coil.

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 each type of product specified.

C. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

D. Samples of cabinet finish colors for approval.

E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Field test reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to compliance with performance requirements of unit ventilators.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm experienced in manufacturing unit ventilators similar to those indicated for this Project and that have a record of successful in-service performance.

B. Comply with ARI 440 for testing and rating units.

C. Comply with ASHRAE 33 for testing steam and hydronic coils.

D. Comply with NFPA 70 for components and installation.

E. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.

1. Unit Ventilator Filters: Furnish one spare filter for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. ABB Aerovent Inc.
2. York
3. Carrier
4. The Trane Co.

2.2 MATERIALS

A. Cabinet: Galvanized steel with removable panels on front and ends.

B. Coil Section Insulation: Faced, heavy-density, glass-fiber insulation over entire section.

C. Adjustable discharge vanes located beneath discharge grilles.

D. Removable inlet grilles.

E. Drain Pans: Galvanized steel, with connection for drain. Drain pan insulated with polystyrene or polyurethane insulation.

F. Plastic Laminate Top Surface: Color and pattern as selected by Architect.

G. Cabinet Finish: Metal surfaces filled, coated with baked-on primer, and finished with manufacturer's standard baked enamel; color as selected by Architect.

2.3 COMPONENTS

A. Unitary Refrigeration Chassis: Condensing unit with suction line accumulator, antislugging devices, crankcase heater, filter, drier, winding thermal protection, overcurrent protection, pressure-limiting valve, and operating controls.

1. Refrigeration Coils: 2-row copper tubes with aluminum fins, conforming to ARI 210. Include thermal expansion valve.
2. Exterior Louver: Extruded aluminum sized to refrigeration unit capacity by manufacturer.

B. Hydronic Cooling Coils: Fin-and-tube coil fabricated of copper, with copper or aluminum fins spaced no closer than 0.1 inch, rated 200 psig. Leak test to 300 psig underwater.

C. Fan and Motor: Centrifugal blower, direct driven by a single phase, 2-speed, electric motor with inherent overload protection and resilient motor/fan mount.

D. Wiring Terminations: Match conductor materials and sizes indicated.

E. Filter: Manufacturer's standard throwaway filter, 1 inch thick, on inlet of each fan.

F. Automatic Temperature Controls: Refer to Division 15 Sections.

G. Safety Devices: Each unit has the following safety devices:

1. Manual disconnect switch completely deenergizes unit.
2. Spring-loaded interlock switch deenergizes control circuit and deenergizes fan and heating elements when front panel is removed.
3. Heat-dissipation switch keeps fans running when unit discharge temperature rises above 100 deg F.
4. Overcurrent protection fuses.
5. Branch circuit fusing to protect heating-element subdivision circuits (maximum 48 A).
6. Motor and control circuit fuses.
7. Low-temperature, cut-out thermostat strapped to air coil prevents coil from freezing and liquid from slugging.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and supports to receive unit ventilators for compliance with requirements for installation tolerances and other conditions affecting performance of unit ventilators. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install unit ventilators as indicated, to comply with manufacturer's written instructions and NFPA 90A.

B. Connect unit ventilators and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

C. Connect fan-coil unit ventilators to hydronic piping according to Division 15 Section "Hydronic Piping." Provide shutoff valve and union or flange at each connection.

3.3 FIELD QUALITY CONTROL

A. Testing: After installing unit ventilators and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

B. Remove and replace malfunctioning units with new units, and retest.

3.4 CLEANING

A. Replace filters in each unit ventilator.

3.5 COMMISSIONING

A. Startup Services: Engage a factory-authorized service representative to provide startup service.

B. Operate fan motor to verify proper rotation.

C. Operate electric heating elements through each stage to verify proper operation and electrical connections.

D. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

END OF SECTION 15840

SECTION 15853 - POWER VENTILATORS

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. Centrifugal roof ventilators.
2. Centrifugal wall ventilators.
3. Ceiling-mounted ventilators.
4. In-line centrifugal fans.

B. Products furnished, but not installed, under this Section include roof curbs for roof-mounted exhaust fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base air ratings on sea-level conditions.

B. Operating Limits: Classify according to AMCA 99.

C. Fan Unit Schedule: The following information is described in an equipment schedule on the Drawings.

1. Fan performance data including capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
2. Fan arrangement including wheel configuration, inlet and discharge configurations, and required accessories.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data including rated capacities of each unit, weights (shipping, installed, and operating), furnished 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 electrical accessories.
4. Material gages and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

D. Coordination Drawings, according to Division 15 Section "Basic Mechanical Requirements," for roof penetration requirements and for reflected ceiling plans drawn accurately to scale and coordinating penetrations and units mounted above ceiling. Show the following:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

E. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

F. Maintenance data for power ventilators to include in the operation and maintenance manual specified in Division 1 and in Division 15 Section "Basic Mechanical Requirements."

1.5 QUALITY ASSURANCE

A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.

B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

C. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.

D. NEMA Compliance: Provide components required as part of fans that comply with applicable NEMA standards.

E. UL Standard: Provide power ventilators that comply with UL 705.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements. Verify clearances.

B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fans have been commissioned.

1.7 COORDINATION AND SCHEDULING

A. Coordinate the size and location of structural steel support members.

B. Coordinate the installation of roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

1.8 EXTRA MATERIALS

A. Furnish one set of belts for each belt-driven fan that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Centrifugal Roof Ventilators:

a. Ammerman Company, Inc.
b. Broan Mfg. Co., Inc.
c. Carnes Co.
d. Central Blower Co.
e. Cincinnati Fan & Ventilator Co.
f. Cook (Loren) Co.
g. Essick Air Products, Breidert.
h. Greenheck Fan Corp.
i. ILG Industries, Inc.
j. Jenn Industries Inc.
k. Lau Division Philips Industries, Inc.
l. Quietaire Corp.

2. Centrifugal Wall Ventilators:

a. Ammerman Company, Inc.
b. Broan Mfg. Co., Inc.
c. Carnes Co.
d. Chelsea Fans & Blowers, Inc.
e. Cook (Loren) Co.
f. Greenheck Fan Corp.
g. ILG Industries, Inc.
h. Jenn Industries Inc.

3. Ceiling-Mounted Ventilators:

a. Ammerman Company, Inc.
b. Broan Mfg. Co., Inc.
c. Carnes Co.
d. Chelsea Fans & Blowers, Inc.
e. Cook (Loren) Co.
f. Greenheck Fan Corp.
g. Essick Air Products, Breidert.
h. FloAire, Inc.
i. ILG Industries, Inc.
j. Jenn Industries Inc.

4. In-Line Centrifugal Fans:

a. Cook (Loren) Co.

b. FloAire, Inc.
c. Greenheck Fan Corp.
d. ILG Industries, Inc.
e. Jenn Industries Inc.

2.2 CENTRIFUGAL ROOF VENTILATORS

A. Description: Belt-driven or direct-drive centrifugal fans, as indicated, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust air stream.

E. Accessories: The following items are required as indicated:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Roof Curbs: Galvanized steel; mitered and welded corners; 2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 2-inch wood nailer. Size as required to suit roof opening and fan base.

a. Configuration: Self-flashing without a cant strip, with mounting flange.
b. Configuration: Built-in cant and mounting flange.
c. Configuration: Built-in raised cant and mounting flange.
d. Overall Height: 8 inches.
e. Overall Height: 12 inches.
f. Overall Height: 18 inches.

2.3 CENTRIFUGAL WALL VENTILATORS

A. Description: Belt-driven or direct-drive centrifugal fans, as indicated, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.

C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust air stream.

E. Accessories: The following items are required as indicated:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Wall Grille: Ring type for flush mounting.
5. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.

2.4 CEILING-MOUNTED VENTILATORS

A. Description: Centrifugal fans designed for installing in ceiling or wall, or for concealed in-line applications.

B. Housing: Galvanized steel lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Stainless-steel, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent.

G. Accessories: Manufacturer's standard roof jack or wall cap, and transition fittings.

2.5 IN-LINE CENTRIFUGAL FANS

A. Description: In-line, belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, drive assembly, motor and disconnect switch, mounting brackets, and accessories.

B. Housing: Split, spun-aluminum housing, with aluminum straightening vanes; inlet and outlet flanges; and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor encased in housing out of air stream, factory wired to disconnect located on outside of fan housing.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories: The following accessories are required as indicated:

1. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
2. Companion Flanges: For inlet and outlet duct connections.
3. Fan Guards: Expanded metal in removable frame. Provide belt guards for units not connected to ductwork.

2.6 MOTORS

A. Refer to Division 15 Section "Motors" for general requirements for factory-installed motors.

B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.

C. Enclosure Type: The following features are required as indicated:

1. Open dripproof motors where satisfactorily housed or remotely located during operation.
2. Guarded dripproof motors where exposed to contact by employees or building occupants.

2.7 FACTORY FINISHES

A. Sheet Metal Parts: Prime coat before final assembly.

B. Exterior Surfaces: Baked-enamel finish coat after assembly.

C. Aluminum Parts: No finish required.

2.8 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required as indicated:

1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements of installation tolerances and other conditions affecting performance of the power ventilators. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install power ventilators according to manufacturer's written instructions.

B. Support units using the vibration-control devices indicated. Vibration-control devices are specified in Division 15 Section "Vibration Control."

1. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

a. Installation of roof curbs is specified in Division 7 Sections.

2. Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.
3. Ceiling Units: Suspend units from structure using steel wire or metal straps.

C. Install units with clearances for service and maintenance.

3.3 HOUSEKEEPING BASES

A. Construct concrete housekeeping pads as follows:

1. Coordinate size of housekeeping bases with actual unit sizes provided. Construct base 4 inches larger, in both directions, than the overall dimensions of the supported unit.
2. Form concrete pads with steel channels conforming to ASTM A 36, size and location as indicated. Miter and weld corner and provide cross bracing. Anchor or key to floor slab.
3. Form concrete pads with framing lumber with form-release compounds. Chamfer top edge and corners of pad.
4. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
5. Place concrete and allow to cure before installing units. Use portland cement conforming to ASTM C 150, 4000-psi compressive strength, and normal-weight aggregate.
6. Clean exposed steel form according to SSPC Surface Preparation Specifications SP 2 or SP 3 and apply 2 coats of rust-preventive metal primer.

3.4 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

B. Electrical: Conform to applicable requirements in Division 16 Sections.

C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of fans, including duct and electrical connections, and to report results in writing.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

3.7 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.8 COMMISSIONING

A. Final Checks before Startup: Perform the following operations and checks before startup:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ducts, and electrical components are complete. Verify that 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 bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the fully open position.
7. Disable automatic temperature-control operators.

B. Starting procedures for fans are as follows:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
2. Measure and record motor 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.

E. Replace fan and motor pulleys as required to achieve design conditions.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

B. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."

C. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

D. Demonstrate operation of power ventilators. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each power ventilator.

END OF SECTION 15853

SECTION 15891 - METAL DUCTWORK

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."

1.2 SUMMARY

A. This Section includes rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gage.

1.3 DEFINITIONS

A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.5 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:

1. Sealing Materials.
2. Fire-Stopping Materials.

C. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:

1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.
3. Fittings.
4. Reinforcing details and spacing.
5. Seam and joint construction details.
6. Penetrations through fire-rated and other partitions.
7. Terminal unit, coil, and humidifier installations.
8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

D. Coordination drawings for ductwork installation in accordance with Division 15 Section "Basic Mechanical Requirements." In addition to the requirements specified in "Basic Mechanical Requirements" show the following:

1. Coordination with ceiling suspension members.
2. Spatial coordination with other systems installed in the same space with the duct systems.
3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.

E. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.

F. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 15 Section "Basic Mechanical Requirements" and Division 1.

G. Maintenance data for volume control devices, fire dampers, and smoke dampers, in accordance with Division 15 Section "Basic Mechanical Requirements" and Division 1.

1.6 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."

B. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.

C. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.

2. NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors for Commercial Cooking Equipment," Chapter 3, "Duct System," for kitchen hood duct systems, except as indicated otherwise.

D. Field-Constructed Mock-Up: Prior to installation of duct systems erect mock-ups representing duct systems pressure classifications greater than 2 inches. Build mock-ups to comply with the following requirements, using materials indicated for final unit of Work.

1. Locate mock-ups on the site. Mock-up may be a representative section of the actual duct system.
2. Include the minimum number of each of the following features and fittings:

a. Five transverse joints.
b. One access door.
c. Two typical branch connections each with at least one elbow.
d. Two typical flexible duct or flexible connector connections for each type duct and apparatus.

3. Perform tests specified in "Field Quality Control." Modify mock-up construction and perform additional tests as required to achieve specified minimum acceptable results.
4. Obtain approval of mock-ups before beginning final fabrication.
5. Retain and maintain mock-ups during construction in undisturbed condition as a standard for judging completed unit of Work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle sealant fire-stopping materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Sheet Metal, General: Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700.

B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 SEALING MATERIALS

A. Joint and Seam Sealants, General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

B. Joint and Seam Tape: 2 inches wide, glass-fiber-fabric reinforced.

C. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.

D. Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 75 percent solids.

E. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

2.3 FIRE-STOPPING

A. Fire-Resistant Sealant: Provide one-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

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. "Dow Corning Fire Stop Foam"; Dow Corning Corp.
2. "Pensil 851"; General Electric Co.
3. "Dow Corning Fire Stop Sealant"; Dow Corning Corp.
4. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.
5. "RTV 7403"; General Electric Co.
6. "Fyre Putty"; Standard Oil Engineered Materials Co.

2.4 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.

B. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.

1. Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
2. Straps and Rod Sizes: Conform with Table 4-1 in SMACNA HVAC Duct Construction Standards, 1985 Edition, for sheet steel width and gage and steel rod diameters.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.

1. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.

2.5 RECTANGULAR DUCT FABRICATION

A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.

1. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

B. Fabricate kitchen hood exhaust ducts with 16-gage, carbon steel sheets for concealed ducts and 18-gage stainless steels for exposed ducts. Weld and flange seams and joints. Conform to NFPA Standard 96.

C. Fabricate dishwasher hood exhaust ducts with 18-gage stainless steels. Weld and flange seams and joints.

D. Acid-Resistant Ducts: Provide factory-fabricated ducts and fittings only; no shop or field fabrication will be allowed. Refer to PVC-Coated Galvanized Steel Sheets in this Section for materials.

E. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:

1. Supply Ducts: 3 inches water gage.
2. Return Ducts: 2 inches water gage, negative pressure.
3. Exhaust Ducts: 2 inches water gage, negative pressure.

F. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.

2.6 RECTANGULAR DUCT FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 1985 Edition, Figures 2-1 through 2-10.

2.7 ROUND AND FLAT OVAL DUCT FABRICATION

A. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.

B. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," 1985 Edition, Figure 3-1, RL-1, RL-4, or RL-5. Seams Types RL-2 or RL-3 may be used if spot-welded on 1-inch intervals. Comply with SMACNA "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gages.

2.8 ROUND AND FLAT OVAL SUPPLY AND EXHAUST FITTINGS FABRICATION

A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 1985 Edition, Figures 3-4 and 3-5 and with metal thicknesses specified for longitudinal seam straight duct.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:

1. Mitered Elbows: Fabricate mitered elbows with welded construction in gages specified below.

a. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," Table 3-1.
b. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:

1) 3 to 26 inches: 24 gage.
2) 27 to 36 inches: 22 gage.
3) 37 to 50 inches: 20 gage.
4) 52 to 60 inches: 18 gage.
5) 62 to 84 inches: 16 gage.

c. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:

1) 3 to 14 inches: 24 gage.
2) 15 to 26 inches: 22 gage.
3) 27 to 50 inches: 20 gage.
4) 52 to 60 inches: 18 gage.
5) 62 to 84 inches: 16 gage.

d. Flat Oval Mitered Elbows: Solid welded and with the same metal thickness as longitudinal seam flat oval duct.
e. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vanes.

2. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.
3. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.
4. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.
5. Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gage with 2-piece welded construction.

6. Round Gored Elbows Gages: Same as for nonelbow fittings specified above.
7. Flat Oval Elbows Gages: Same as longitudinal seam flat oval duct.
8. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 26 gage.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION, GENERAL

A. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.

B. Install ducts with the fewest possible joints.

C. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

D. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

E. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

H. Install insulated ducts with 1-inch clearance outside of insulation.

I. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

J. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

K. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

L. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

3.2 KITCHEN HOOD EXHAUST DUCT INSTALLATIONS

A. Provide for thermal expansion of ductwork through 2,000-deg F temperature range.

B. Install without dips or traps that may collect residues, except where traps have continuous or automatic residue removal.

C. Install access openings at each change in direction and at 50-foot intervals. Locate on sides of duct 1-1/2 inches minimum from bottom, and fit with grease-tight covers of same material as duct.

D. Do not penetrate fire-rated assemblies.

3.3 DISHWASHER EXHAUST DUCT INSTALLATIONS

A. Install dishwasher exhaust duct systems in accordance with SMACNA "HVAC Duct Construction Standards," 1985 Edition, Figure 2-21.

3.4 SEAM AND JOINT SEALING

A. General: Seal duct seams and joints as follows:

B. Pressure Classifications Greater Than 3 Inches Water Gage: All transverse joints, longitudinal seams, and duct penetrations.

C. Pressure Classification 2 and 3 Inches Water Gage: All transverse joints and longitudinal seams.

1. Pressure Classification Less than 2 Inches Water Gage: Transverse joints only.

D. Seal externally insulated ducts prior to insulation installation.

3.5 HANGING AND SUPPORTING

A. Install rigid round, rectangular, and flat oval metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.

B. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

C. Support vertical ducts at a maximum interval of 16 feet and at each floor.

D. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

E. Install concrete insert prior to placing concrete.

F. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.6 CONNECTIONS

A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 15 Section "Duct Accessories."

B. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-7 and 2-8.

C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-16 through 2-18.

D. Terminal Units Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figure 2-19.

3.7 FIELD QUALITY CONTROL

A. The Owner will contract with an independent testing agency to perform, record, and report leakage tests.

B. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

3.8 ADJUSTING AND CLEANING

A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 15 Section "TESTING, ADJUSTING, AND BALANCING" for requirements and procedures for adjusting and balancing air systems.

B. Vacuum ducts systems prior to final acceptance to remove dust and debris.

END OF SECTION 15891

SECTION 15932 - AIR OUTLETS AND INLETS

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 DESCRIPTION OF WORK:

A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.

B. Types of outlets and inlets required for project include the following:

1. Ceiling air diffusers.
2. Wall registers and grilles.
3. Louvers.

C. Refer to other Division-15 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this section.

D. Refer to other Division-15 sections for balancing of air outlets and inlets; not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
4. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.
5. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".
6. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.
7. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings. Indicate selections on data.

B. Samples: 3 samples of each type of finish furnished.

C. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

D. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 CEILING AIR DIFFUSERS:

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule. The following requirements shall apply to nomenclature indicated on schedule.

1. Diffuser Faces:

a. Round (RD): Round housing, core of concentric rings, round duct connection.
b. Square (SQ): Square housing, core of square concentric louvers, square or round duct connection.
c. Rectangular (RCT): Rectangular housing, core of rectangular concentric louvers, square or round duct connection.

d. Perforated (PR): Round, square, or rectangular housing covered with removable perforated panel in frame. Conceal air pattern devices above panel.
e. Linear (LR): Extruded aluminum continuous slot, single or multiple.

2. Diffuser Mountings:

a. Flush (FL): Diffuser housing above ceiling surface with flush perimeter flange and gasket to seal against ceiling.
b. Lay-In (L-I): Diffuser housing sized to fit between ceiling exposed suspension tee bars and rest on top surface of tee bar.

3. Diffuser Patterns:

a. Fixed (FX): Fixed position core with concentric rings or louvers for radial air flow around entire perimeter of diffuser.
b. 1 Way (1-W): Fixed louver face for 1-direction air flow, direction indicated on drawings.
c. 2 Way (2-W): Fixed louver face for 2-direction air flow, directions indicated on drawings.
d. 3 Way (3-W): Fixed louver face for 3-direction air flow, directions indicated on drawings.
e. 4 Way (4-W): Fixed louver face for 4-direction air flow, directions indicated on drawings.

4. Diffuser Dampers:

a. Opposed Blade (O-B): Adjustable opposed blade damper assembly, key operated from face of diffuser.
b. Butterfly (BTFY): Two semicircular flaps connected to linkage adjustable from face of diffuser with key, and with straightening grid.

5. Diffuser Accessories:

a. Plaster Ring (P-R): Perimeter ring designed to act as a plaster stop and diffuser anchor.
b. Extractor (EXTR): Curved blades mounted on adjustable frame to produce air scooping action in duct at diffuser take-off.

6. Diffuser Finishes:

a. White Enamel (W-E): Semi-gloss white enamel prime finish.
b. Aluminum Anodize (A-A): Aluminum etched and anodized, covered with clear lacquer finish.

E. Available Manufacturers: Subject to compliance with requirements, manufacturers offering diffusers which may be incorporated in the work include, but are not limited to, the following:

1. Anemostat Products Div.; Dymanics Corp. of America.
2. Cranes Co.; Div. of Wehr Corp.
3. Krueger Mfg. Co.
4. Titus Products Div.; Philips Industries, Inc.
5. Tuttle & Bailey; Div. of Interpace Corp.

2.2 WALL REGISTERS AND GRILLES:

A. General: Except as otherwise indicated, provide manufacturer's standard wall registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

D. Types: Provide wall registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule. The following requirements shall apply to nomenclature indicated on schedule:

1. Register and Griller Materials:

   a. Aluminum Construction (AL): Manufacturer's standard extruded aluminum frame and adjustable blades.

2. Register and Grille Faces:

   a. Horizontal Straight Blades (H-S): Horizontal blades, individually adjustable, at manufacturer's standard spacing.
   b. Vertically Straight Blades (V-S): Vertical blades, individually adjustable, at manufacturer's standard spacing.
   c. Horizontal 45 Degree Fixed Blades (H-45 Degrees): Horizontal blades, fixed at 45 degrees, at manufacturer's standard spacing.

3. Register and Grille Patterns:

   a. Single Deflection (S-D): 1-set of blades in face.
   b. Double Deflection (D-D): 2-sets of blades in face, rear set at 90 degrees to face set.

4. Register and Grille Dampers:

   a. Opposed Blade (O-B): Adjustable opposed blade damper assembly, key operated from face of register.

5. Register and Grille Accessories:

   a. Extractor (EXTR): Curved blades mounted on adjustable frame to produce air scooping action in duct at register or grille take-off.
   b. Plaster Frame (P-F): Perimeter frame designed to act as plaster stop and register or grille anchor.
   c. Operating Keys (OP-KY): Tools designed to fit through register or grille face and operate volume control device and/or pattern adjustable.

6. Register and Grille Finishes:

   a. White Enamel (W-E): Semi-gloss white enamel prime finish.

b. Aluminum Anodize (A-A): Aluminum etched and anodized, covered with clear lacquer finish.

E. Available Manufacturers: Subject to compliance with requirements, manufacturers offering registers and grilles which may be incorporated in the work include, but are not limited to, the following:

1. Anemostat Products Div.; Dynamics Corp. of America.
2. Carnes Co.; Div. of Wehr Corp.
3. Titus Products Div.; Philips Industries, Inc.

2.3 LOUVERS:

A. General: Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide louvers that have minimum free area, and maximum pressure drop of each type as listed in manufacturer's current data, complying with louver schedule.

C. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.

D. Materials: Construct of aluminum extrusions, ASTM B 221, Alloy 6063-T52. Weld units or use stainless steel fasteners.

E. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

F. Available Manufacturers: Subject to compliance with requirements, manufacturers offering louvers which may be incorporated in the work include, but are not limited to, the following:

1. Airline Products Co.
2. Airolite Co.
3. American Warming & Ventilating Inc.
4. Arrow United Industries, Inc.
5. Construction Specialties, Inc.
6. Dowco Corp.
7. Industrial Louvers, Inc.
8. Louvers & Dampers, Inc.
9. Penn Ventilator Co., Inc.
10. Ruskin Mfg. Co.
11. Safe-Air Inc.
12. Snyder (E.G.) Co., Inc.
13. Vent Products Co., Inc.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended function.

B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

3.3 SPARE PARTS:

A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

END OF SECTION 15932

SECTION 15975 - CONTROL SYSTEMS EQUIPMENT

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 control equipment for HVAC systems and components, including control components for terminal heating and cooling units that are not supplied with factory-wired controls.

1.3 SYSTEM DESCRIPTION

A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories connected to controllers to operate mechanical systems according to sequences of operation indicated or specified.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product Data for each type of product specified. Include manufacturer's technical Product Data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, installation instructions, and startup instructions.

C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Submit damper leakage and flow characteristics, plus size schedule for controlled dampers.

D. Wiring diagrams detailing wiring for power, signal, and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

E. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer specializing in control system installations.

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing control systems similar to those indicated for this Project and that have a record of successful in-service performance.

C. Startup Personnel Qualifications: Engage specially trained personnel in direct employ of manufacturer of primary temperature control system.

D. Comply with NFPA 90A.

E. Comply with NFPA 70.

F. Coordinate equipment selection with Division 16 Section "Fire Alarm Systems" to achieve compatibility with equipment that interfaces with that system.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store equipment and materials inside and protected from weather.

B. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Direct Digital Control (DDC) Systems and Components:

a. Alerton Technologies, Inc.
b. American Auto-Matrix, Inc.
c. Andover Controls Corp.
d. Automated Logic Corporation.
e. Barber-Coleman Co.; Environmental Controls.
f. Condyne Technology, Inc.
g. CSI Control Systems International, Inc.
h. Danfoss-EMC, Inc.
i. Demand Technologies, Inc.
j. EDA Controls Corp.
k. Electronic Systems USA, Inc.
l. Functional Devices Inc.
m. G C Controls, Inc.
n. Heat-Timer Corp.
o. Honeywell, Inc.; Commercial Buildings Group.
p. Integrated Energy Controls Corp.
q. Johnson Controls, Inc.; Controls Group.
r. Landis & Gyr Powers, Inc.
s. Luwa Bahnson Inc.
t. Pneuline Controls Co.
u. Robertshaw Controls Co.
v. Scientific-Atlanta; Control Systems Div.
w. Siebe Environmental Controls; Barber-Coleman/Robertshaw Products.
x. SnyderGeneral Corp.
y. Solidyne Corp.
z. Staefa Control System, Inc.
aa. TCS/BASYS Controls.
ab. Teletrol Systems Inc.
ac. Thorn Automated Systems, Inc.

ad. Trane Co. (The); Commercial Systems Group.
ae. Triangle MicroSystems, Inc.

2.2 DIRECT DIGITAL CONTROL (DDC) EQUIPMENT

A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and back-up power source.

1. Units monitor or control each input/output point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator station.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse input/output.
c. Monitoring, controlling, or addressing data points.
d. Testing and developing control algorithms without disrupting field hardware and controlled environment.

B. Local Area Networks (LANs): Not less than 60 stations or nodes at minimum 19.2 kB.

1. System Support: Capacity for a minimum of 10 workstations connected to multiuser, multitasking environment with concurrent capability to access DDC network or control units.

C. Software: Update to latest version of software at project completion. Include and implement the following capabilities from the control units:

1. Units of Measure: Inch-pound and SI metric.
2. Load Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, DDC with fine tuning, and trend logging.
3. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
4. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
5. Programming Application Features: Include trend point, alarm messages, weekly scheduling, and interlocking.

2.3 CONTROL PANELS

A. Central (Master) Control Panels: Fully enclosed, steel-rack-type cabinet with locking doors or locking removable backs. Match finish of panels and provide multicolor graphic displays, schematically showing system being controlled.

B. Local Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.

1. Fabricate panels of 0.06-inch-thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color.
2. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.
3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
4. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.

C. Alarm Panels: Indicating light for each alarm point, single horn, ACKNOWLEDGE switch, and TEST switch, mounted in hinged-cover enclosure.

1. Alarm Condition: Indicating light flashes and horn sounds.
2. ACKNOWLEDGE Switch: Horn silent and indicating light steady.
3. Second Alarm: Horn sounds and indicating light steady.
4. Alarm Condition Cleared: System reset and indicating light extinguished.
5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.4 ANALOG CONTROLLERS

A. Step Controllers: 6-stage or 10-stage type, with heavy-duty switching rated to handle loads, UL listed and operated by electric motor.

B. Electric Outdoor Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range -10 to 70 deg F, and single- or, double-pole contacts.

C. Electronic Controllers: Wheatstone bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing proportional control of motor speed from maximum to minimum of 55 percent (field adjustable). Provide ON-OFF action below minimum fan speed. Design controller to apply full voltage briefly when motor is started to bring motor up to minimum speed rapidly. Equip with filter circuit to eliminate objectionable radio interference.

E. Receiver Controllers: Single- or dual-input models with control-point adjustment direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, and authority adjustment. Provide proportional control mode.

1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal 3 to 13 psi.
2. Proportional band shall extend from 2-1/2 to 40 percent of primary sensor span, authority from 10 to 200 percent of primary sensor span.
3. Suitable for supply air pressure of 18 psi, input signal of 3 to 15 psi, and output signal 0 to 15 psi.

2.5 TIME CLOCKS

A. Seven-day, programming-switch timer with synchronous-timing motor and 7-day dial; continuously charged, nickel-cadmium-battery-driven, 8-hour, power-failure carryover; multiple-switch trippers; minimum of 2 and maximum of 8 signals per day with 2 normally open and 2 normally closed output contacts.

B. Solid-state, programmable time control with 4 separate programs; 24-hour battery carryover; individual ON-OFF-AUTO switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; and system fault alarm.

2.6 SENSORS

A. Electronic Sensors: Vibration and corrosion resistant, for wall, immersion, or duct mounting as required.

1. Resistance Temperature Detectors: Platinum.

    a. Accuracy: Plus or minus 0.2 percent at calibration point.
    b. Wire: Twisted, shielded-pair cable.
    c. Insertion Elements in Ducts: Use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
    d. Averaging Elements in Ducts: Use where ducts are larger than 9 sq. ft. or where prone to stratification, length as required.
    e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
    f. Room Sensors: Match room thermostats, locking cover.
    g. Outside Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
    h. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

2. Humidity Sensors: Bulk polymer sensor element.
    a. Accuracy: 5 percent full range with linear output.
    b. Room Sensors: With locking cover matching room thermostats, span of 25 to 90 percent relative humidity.
    c. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

3. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, temperature compensated.

    a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
    b. Output: 4 to 20 mA.
    c. Building Static-Pressure Range: 0 to 0.25 inch wg.
    d. Duct Static-Pressure Range: 0 to 5 inches wg.

4. Pressure Transmitters: Direct acting for gas, liquid, or steam service, range suitable for system, proportional output 4 to 20 mA.

B. Equipment Operation Sensors: As follows:
1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 inches wg.
2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psi.

3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

C. Digital-to-Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs, or continuous proportional current or voltage to 0 to 20 psi.

D. Valve/Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent valve/damper travel.

E. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vaporproof type.

2.7 THERMOSTATS

A. Combination Thermostat and Fan Switches: Line-voltage thermostat with 2-, 3-, or 4-position, push-button or lever-operated, fan switch.

1. Label switches "FAN ON-OFF," "FAN HIGH-LOW-OFF," "FAN HIGH-MED-LOW-OFF." Provide unit for mounting on 2-gang switch box.

B. Low-Voltage, ON-OFF Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater.

C. Line-Voltage, ON-OFF Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual ON-OFF-AUTO selector switch; UL listed for electrical rating.

1. Equip thermostats, which control electric heating loads directly, with OFF position on dial wired to break ungrounded conductors.
2. Dead Band: Maximum 2 deg F.

D. Low-Voltage Modulating Thermostats: Potentiometer, operated by vapor-filled bellows.

E. Remote-Bulb Thermostats: ON-OFF or modulating type, liquid-filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. ON-OFF, remote-bulb thermostats with precision snap switches, with electrical ratings required by application.
6. Construct modulating, remote-bulb, potentiometer thermostats so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

F. Fire-Protection Thermostats: UL listed with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, with the following:

1. Reset: Manual.
2. Reset: Automatic with control circuit arranged to require manual reset at central control panel, with pilot light and reset switch on panel labeled to indicate operation.

G. Pneumatic Room Thermostats: 2-pipe, nonbleed or relay type, fully proportional with adjustable throttling range and tamperproof locking settings, direct or reverse acting as required, factory calibrated at 2.5 psi/deg F. Provide single or dual temperature as required by sequence of operations.

1. Set-Point Adjustment: Minimum 40 deg F set-point adjustment and adjustable dead band.
2. Dual-Temperature Thermostats: Automatic changeover from normal setting to lower unoccupied setting, with manual reset lever to permit return to normal temperatures during unoccupied cycles, with automatic reset to normal during next cycle of operation.

H. Room Thermostat Construction: Manufacturer's standard locking covers.

1. Thermometer: Red-reading glass or spiral bimetal.
2. Guards: Heavy-duty, clear plastic or metal-wire, tamperproof guards.
3. Locking Covers: With only temperature indication visible.
4. Limits: Provide on heating/cooling dual-temperature thermostats, to prevent setting cooling set point below 75 deg F, and heating set point above 75 deg F.

I. Room Thermostat Accessories: As follows:

1. Insulating Bases: For thermostats located on exterior walls.
2. Thermostat Guards: Locking transparent-plastic mounted on separate base.
3. Adjusting Key: As required for device.
4. Aspirating Boxes: Where indicated for thermostats requiring flush installation.

J. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

K. Airstream Thermostats: 2-pipe, fully proportional, single temperature, with adjustable set point in middle of range and adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

L. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet.
2. Quantity: 1 thermostat for every 20 sq. ft. of coil surface.

M. Electric High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.

1. Bulb Length: Minimum 20 feet.
2. Quantity: 1 thermostat for every 20 sq. ft. of coil surface.

N. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psi, cast housing with position indicator and adjusting knob.

2.8 HUMIDISTATS

A. Pneumatic Room Humidistats: Wall-mounted, proportioning type with adjustable throttling range (5 percent), 30 to 80 percent operating range, cover with finish matching room thermostats with set-point indication.

B. Duct-Mounted Humidistats: Electric insertion, 2-position type with adjustable 2 percent throttling range, 20 to 80 percent operating range, single- or double-pole contacts.

2.9 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or 2-position action.

1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
2. Nonspring-Return Motors for Valves Larger Than 2-1/2 Inches: Size for running torque of 150 inch-pounds and breakaway torque of 300 inch-pounds.
3. Spring-Return Motors for Valves Larger Than 2-1/2 Inches: Size for running and breakaway torque of 150 inch-pounds.
4. Nonspring-Return Motors for Dampers Larger Than 25 sq. ft.: Size for running torque of 150 inch-pounds and breakaway torque of 300 inch-pounds.
5. Spring-Return Motors for Dampers Larger Than 25 sq. ft.: Size for running and breakaway torque of 150 inch-pounds.

B. Pneumatic Valve Operators: Rolling-diaphragm, spring-loaded, piston type with spring range as required. Select operator for full shutoff at maximum pump differential pressure.

C. Pneumatic Damper Operators: Rolling-diaphragm, piston type with adjustable stops and spring return, sized to operate with sufficient reserve power to provide smooth modulating action or 2-position action. Where actuators operate in sequence, provide pilot positioners.

1. Pilot Positioners: Starting point adjustable from 2 to 12 psi and operating span adjustable from 5 to 13 psi.
2. Inlet Vane Operators: High pressure with pilot positioners.

D. Electronic Operators: Select operator for full shutoff at maximum pump differential pressure.

2.10 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class indicated. Where type or body material is not indicated, make selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system.

B. Globe Pattern: As follows:

1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
3. Hydronic Systems: As follows:
    a. Rating: Service at 125 psi WSP and 250 deg F.
    b. Internal Construction: Replaceable plugs and seats of stainless steel or brass.

        1) Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
        2) Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.

    c. Sizing: 3-psi maximum pressure drop at design flow rate.
    d. Flow Characteristics: 2-way valves have equal percentage characteristics; 3-way valves have linear characteristics. Select operators to close valves against pump shutoff head.

4. Steam Systems: As follows:

    a. Rating: Service at 125 psi WSP and 250 deg F.
    b. Internal Construction: Replaceable plugs and seats of stainless steel.

        1) Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
        2) Double-Seated Valves: Balanced plug; Cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.

    c. Sizing: 10-psi inlet pressure and 5-psi pressure drop.
    d. Sizing: Pressure drop across steam valve at a maximum flow of 80 percent of inlet pressure for low-pressure systems and 42 percent for high-pressure systems.
    e. Flow Characteristics: Modified linear characteristics.

C. Butterfly Pattern: Iron body; bronze, aluminum-bronze, or stainless-steel disc; resilient, replaceable seat for service to 180 deg F wafer or lug ends; extended neck.

1. Rating: Service at 125 psi WSP and 250 deg F.
2. Sizing: 1-psi maximum pressure drop at design flow rate.

D. Terminal Unit Control Valves: Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.

1. Rating: Service at 125 psi WSP and 250 deg F.
2. Sizing: 3-psi maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: 2-way valves have equal percentage characteristics; 3-way valves have linear characteristics.
4. Operators (2 Position): Synchronous motor with enclosed gear train, dual-return springs, valve-position indicator. Valves spring return to normal position for temperature protection.
5. Operators (Modulating): Self-contained, linear motor, actuator with 60-second full travel, with transformer and single-throw, double-pole contacts.

2.11 DAMPERS

A. Dampers: AMCA-rated, parallel or opposed blade design; form frames from not less than 0.1084-inch galvanized steel with mounting holes for duct mounting; damper blades not less than 0.0635-inch galvanized steel, with maximum blade width of 8 inches.

1. Blades secured to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass. Ends sealed against spring-stainless-steel blade bearings. Thrust bearings at each end of every blade.
2. Operating Temperature Range: From -40 to 200 deg F.
3. For standard applications as indicated, (as selected by manufacturer's sizing techniques) with optional closed-cell neoprene edging.
4. For low-leakage applications as indicated, provide parallel or opposed blade design (as selected by manufacturer's sizing techniques) with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm/sq. ft. of damper area, at differential pressure of 4 inches wg when damper is being held by torque of 50 inch-pounds; test in accordance with AMCA 500.

2.12 AIR SUPPLY

A. Control and Instrumentation Tubing: Seamless copper tubing; Type K, ASTM B 88 or Type ACR, ASTM B 280; with cast-bronze solder-joint fittings, ASME B16.18; or wrought-copper solder-joint fittings, ASME B16.22; soldered or brazed; except forged brass compression-type fittings at connections to equipment.

B. Control and Instrumentation Tubing: Virgin-polyethylene, flame-retardant, nonmetallic tubing, ASTM D 2737, and with flame-retardant harness for multiple tubing; compression or push-on polyethylene fittings.

C. Tank: ASME storage tank with drain test cock, automatic moisture removal trap, tank relief valve, and rubber-cork vibration isolation mounting pads.

D. Duplex Air Compressor: Unit with automatic alternator to equalize running time of each unit, capacity to supply compressed air to temperature control system.

1. Pressure Control: Adjustable electric contacts, set to start and stop both compressors at different pressures.
2. Electrical Alternation Set: With motor starters and disconnect to operate compressors alternately or on time schedule.

E. Simplex Air Compressor: Tank-mounted compressor with capacity to supply compressed air to temperature control system, with starter and disconnect.

1. Pressure Control: Adjustable electric contacts, set to start and stop compressor.

F. Size compressor and tank to operate compressor not more than the following amount of time during a one-hour period:

1. Operating Time: 20 minutes.
2. Operating Time: 30 minutes.

G. Compressor Accessories: Equip with the following:

1. Low-resistance intake air filter.
2. Belt guards.

H. System Accessories: Equip with the following:

1. Air filter rated for 97 percent efficiency at rated air flow.
2. Combination filter/pressure-reducing station or separate filter and pressure-reducing station.

I. Refrigerated Air Drier: Self-contained, refrigerated air drier complete with heat exchangers, moisture separator, internal wiring and piping, and with manual bypass valve.

1. Heat Exchangers: Air to refrigerant coils with centrifugal-type moisture separator and automatic trap assembly.
2. Refrigeration Unit: Hermetically sealed, operating to maintain dew point of 13 deg F at 20 psi, housed in steel cabinet with access door and panel.
3. Accessories: Air-inlet temperature gage, air-inlet pressure gage, ON-OFF switch, HIGH TEMPERATURE light, POWER ON light, refrigerant gage on back, air-outlet temperature gage, air-outlet pressure gage, with contacts for remote indication of power status and high-temperature alarm.

J. Desiccant Drier: Obtains dew point in pneumatic air piping between compressor and tank at least 15 deg F below inlet-air dew point at design conditions.

K. Pneumatic Accessories: As follows:

1. Pressure Gages: Manufacturer's standard, black letters on white background, 2-1/2-inch diameter, flush or surface mounted, with front calibration screw to match sensor, in appropriate units.
2. Instrument Pressure Gages: Manufacturer's standard, black letters on white background, 1-1/2-inch diameter, stem mounted, with suitable dial range.
3. Diaphragm Control and Instrument Valves: 1/4-inch forged brass body with reinforced teflon diaphragm, stainless-steel spring, and color-coded phenolic handle.
4. Gage Cocks: Tee or level handle, bronze, rated for 125 psi.
5. Relays: For summing, reversing, amplifying, highest or lowest pressure selection, with adjustable input/output ratio.
6. Switches: With indicating plates, accessible adjustment, calibrated and marked.

L. Pressure Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure build-up, and producing flat reduced-pressure curve.

M. Particle Filters: Zinc or aluminum castings with filtration efficiency at rated air flow of 97 percent, quick-disconnect service devices, aluminum or plastic bowl with metal guard and manual drain cock.

N. Combination Filter/Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure build-up, and producing flat reduced-pressure curve; with threaded pipe connections, quick-disconnect service devices, aluminum or plastic bowl with metal guard and manual drain cock.

O. Airborne Oil Filter: Filtration efficiency of 99.9 percent for particles of 0.025 micrometer or larger particles of airborne lubricating oil.

P. Pressure-Relief Valves: ASME rated and labeled.

1. High Pressure: Size for installed capacity.
2. Low Pressure: Size for installed capacity of pressure regulators and set at 20 percent above low pressure.

Q. Pressure-Reducing Stations: 2 parallel pressure regulators.

2.13 CONTROL CABLE

A. Electronic Cable for Control Wiring: Refer to Division 16 Section "Control/Signal Transmission Media."

B. Optical-Fiber Cable for Control Wiring: Refer to Division 16 Section "Control/Signal Transmission Media."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation. Verify that field end devices, wiring, and pneumatic tubing are installed before proceeding with installation.

3.2 INSTALLATION

A. Install equipment as indicated to comply with manufacturer's written instructions.

B. Install software in control units and operator workstation. Implement all features of programs to specified requirements and appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve the sequence of operation specified.

D. Mount compressor and tank unit on vibration isolation according to Division 15 Section "Vibration Control." Isolate air supply with wire-braid-reinforced rubber hose. Secure and anchor according to manufacturer's recommendations and seismic-control requirements.

1. Pipe manual and automatic drains to nearest floor drain.
2. Supply instrument air from compressor units through filter, pressure-reducing valve, pressure-relief valve, with pressure gages, and shutoff and bypass valves.

E. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate 60 inches above floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

F. Provide guards on thermostats in the following locations:

1. Entrances.
2. Public areas.

3. Where indicated.

G. Install damper motors on outside of duct in warm areas, not where exposed to outdoor temperatures.

H. Install labels and nameplates to identify control components according to Division 15 Sections specifying mechanical identification.

I. Install hydronic instrument wells, valves, and other accessories according to Division 15 Section "Hydronic Piping."

J. Install steam and condensate instrument wells, valves, and other accessories according to Division 15 Section "Steam and Condensate Piping."

K. Install refrigerant instrument wells, valves, and other accessories according to Division 15 Section "Refrigerant Piping."

L. Install duct volume-control dampers according to Division 15 Sections specifying air ducts.
M. Install optical-fiber cable according to Division 16 Section "Control/Signal Transmission Media."

3.3 CONTROL AIR PIPING

A. Mechanical Equipment Rooms: Inside mechanical equipment enclosures, in pipe chases, or suspended ceilings with easy access, install the following:

1. Copper tubing with maximum unsupported length of 36 inches, for tubing exposed to view.
2. Polyethylene tubing in metallic raceways or PVC pipe.

B. Terminal single-line connections less than 18 inches in length may be copper tubing, or polyethylene tubing run inside flexible steel protection.

C. Concealed locations, such as pipe chases, suspended ceilings with easy access, install copper or polyethylene bundled and sheathed tubing.

D. In concrete slabs, furred walls, or ceilings with no access, install copper or polyethylene tubing; install polyethylene tubing in EMT or vinyl-jacketed polyethylene tubing.

1. Protect embedded-copper and vinyl-jacketed polyethylene tubing with EMT extending 6 inches above finished slab and 6 inches into slab. Pressure test tubing before and after pour for leak and pinch.
2. Install polyethylene tube in EMT extending 6 inches above floor line; pull tubing into EMT after pour.

E. Purge tubing with dry, oil-free compressed air before connecting control instruments.

1. Bridge cabinets and doors with flexible connections, fastened neatly along hinge side; protect against abrasion. Tie and support tubing neatly.

F. Solder or braze copper tubing, except at instruments or equipment where compression fittings may be used.

G. Number-code or color-code control air piping, except local individual room control tubing, for future identification and servicing of control system.

H. Pressure Gages or Test Plugs: Install on branch lines at each receiver controller and on signal lines at each transmitter, except individual room controllers.

3.4 ELECTRICAL WIRING AND CONNECTIONS

A. Install raceways, boxes, and cabinets according to Division 16 Section "Raceways, Boxes, and Cabinets."

B. Install building wire and cable according to Division 16 Section "Wires and Cables."

C. Install signal and communication cable according to Division 16 Section "Control/Signal Transmission Media."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where a number of cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, neatly along hinge side; protect against abrasion. Tie and support conductors neatly.
6. Number-code or color-code conductors, except local individual room controls, for future identification and servicing of control system.

D. Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

E. Connect manual reset limit controls independent of manual control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

F. Connect HAND-OFF-AUTO selector switches to override automatic interlock controls when switch is in HAND position.

3.5 FIELD QUALITY CONTROL

A. Pressure test control air piping at 30 psi or 1.5 times the operating pressure for 24 hours, with maximum 5-psi loss.

3.6 COMMISSIONING

A. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to start control systems.

B. Test and adjust controls and safeties.
C. Replace damaged or malfunctioning controls and equipment.

D. Start, test, and adjust control systems.

E. Demonstrate compliance with requirements.

F. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.7 DEMONSTRATION

A. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to demonstrate and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Schedule training with Owner with at least 7 days' notice.
3. Provide operator training on data display, alarm and status descriptors, requesting data, execution of commands, and request of logs. Include a minimum of 40 hours' dedicated instructor time on-site.

END OF SECTION 15975

SECTION 15990 - TESTING, ADJUSTING, AND BALANCING

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 testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Measuring electrical performance of HVAC equipment.
4. Setting quantitative performance of HVAC equipment.
5. Verifying that automatic control devices are functioning properly.
6. Measuring sound and vibration.
7. Reporting results of the activities and procedures specified in this Section.

B. Related Sections include the following:

1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.
2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. Test: A procedure to determine quantitative performance of a system or equipment.

L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

M. AABC: Associated Air Balance Council.

N. AMCA: Air Movement and Control Association.

O. CTI: Cooling Tower Institute.

P. NEBB: National Environmental Balancing Bureau.

Q. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.4 SUBMITTALS

A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.

B. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.

C. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.

D. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

E. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.

F. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

1.5 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

B. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

a. Submittal distribution requirements.
b. Contract Documents examination report.
c. Testing, adjusting, and balancing plan.
d. Work schedule and Project site access requirements.
e. Coordination and cooperation of trades and subcontractors.
f. Coordination of documentation and communication flow.

C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing."

E. Testing, Adjusting, and Balancing Reports: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

F. Testing, Adjusting, and Balancing Reports: Use standard forms from SMACNA's "HVAC Systems--Testing, Adjusting, and Balancing."

G. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.

H. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

I. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 PROJECT CONDITIONS

A. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. National Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms stating that AABC will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

C. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified Agent has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine project record documents described in Division 1 Section "Project Record Documents."

D. Examine Architect's and Engineer's design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings, utilized for supply air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.

R. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices operate by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.

7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to design values.

S. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so design conditions for system operations can be met.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards and this Section. Or

B. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

C. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

D. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

3.5 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems. Additional procedures are required for variable-air-volume, multizone, dual-duct, induction-unit supply-air systems and process exhaust-air systems. These additional procedures are specified in other articles in this Section.

B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each air-handling unit component.

    a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Adjust fan speed higher or lower than design with the approval of the Architect. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-

motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at design flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 HYDRONIC SYSTEMS' BALANCING PROCEDURES

A. Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.

E. Adjust balancing stations to within specified tolerances of design flow rate as follows:

1. Determine the balancing station with the highest percentage over design flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.8 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating if high-efficiency motor.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper

operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.9 CONDENSING UNITS

A. Verify proper rotation of fans and measure entering- and leaving-air temperatures. Record compressor data.

3.10 TEMPERATURE TESTING

A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.11 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Verify free travel and proper operation of control devices such as damper and valve operators.

F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.

G. Confirm interaction of electrically operated switch transducers.

H. Confirm interaction of interlock and lockout systems.

I. Verify main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine if the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.12 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.

2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Heating-Water Flow Rate: 0 to minus 10 percent.
4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.13 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.14 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of testing, adjusting, and balancing Agent.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of testing, adjusting, and balancing Agent who certifies the report.
10. Summary of contents, including the following:

a. Design versus final performance.
b. Notable characteristics of systems.
c. Description of system operation sequence if it varies from the Contract Documents.

11. Nomenclature sheets for each item of equipment.
12. Data for terminal units, including manufacturer, type size, and fittings.
13. Notes to explain why certain final data in the body of reports vary from design values.
14. Test conditions for fans and pump performance forms, including the following:
    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings, including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Sheave dimensions, center-to-center and amount of adjustments in inches.
    j. Number of belts, make, and size.
    k. Number of filters, type, and size.

2. Motor Data: Include the following:

    a. Make and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Sheave dimensions, center-to-center and amount of adjustments in inches.

3. Test Data: Include design and actual values for the following:

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.
    f. Preheat coil static-pressure differential in inches wg.

g. Cooling coil static-pressure differential in inches wg.
h. Heating coil static-pressure differential in inches wg.
i. Outside airflow in cfm.
j. Return airflow in cfm.
k. Outside-air damper position.
l. Return-air damper position.
m. Vortex damper position.

G. Apparatus-Coil Test Reports: For apparatus coils, include the following:

1. Coil Data: Include the following:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch.
f. Make and model number.
g. Face area in sq. ft.
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outside-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data: Include the following:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Sheave dimensions, center-to-center and amount of adjustments in inches.

2. Motor Data: Include the following:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches.
g. Number of belts, make, and size.

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:

a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Design airflow rate in cfm.
h. Design velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

J. Air-Terminal-Device Reports: For terminal units, include the following:

1. Unit Data: Include the following:

a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.
f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.
i. Air-terminal-device effective area in sq. ft.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data: Include the following:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data: Include design and actual values for the following:

   a. Airflow rate in cfm.
   b. Entering-water temperature in deg F.
   c. Leaving-water temperature in deg F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in deg F.
   f. Leaving-air temperature in deg F.

L. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:

   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.15 ADDITIONAL TESTS

A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION 15990

SECTION 16500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Basic electrical methods.
2. Grounding and bonding.
3. Hangers and supports.
4. Electrical identification.
5. Motor Starters, controls, and connections to mechanical equipment.
6. Electrical system testing and inspection.

B. Related Documents: The Contract Documents, as defined in Section 011000 - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other documents.

C. Related Sections:
1. Section 019113 - General Commissioning Requirements
2. Section 078400 - Firestopping
3. Section 220500 - Common Work Results for Plumbing
4. Section 230500 - Common Work Results for HVAC
5. Section 230915 - Variable Frequency Motor Controllers
6. Section 160519 - Low-Voltage Electrical Power Conductors and Cables.
7. Section 160533 - Raceway and Boxes for Electrical Systems
8. Section 160623 - Lighting Control Devices
9. Section 160800 - Commissioning of Electrical Systems
10. Section 162200 - Low Voltage Transformers
11. Section 162416 - Panelboards
12. Section 162726 - Wiring Devices
13. Section 162816 - Enclosed Switches and Circuit Breakers
14. Section 165100 - Interior Lighting
15. Section 183100 - Fire Detection and Alarm
16. Section 337173 - Electrical Utility Services

1.2 REFERENCES

A. National Electrical Contractors Association (NECA):
1. NECA SI - Standard of Installation.

B. National Electrical Manufacturers Association (NEMA):
1. NEMA KS 1 - Enclosed Switches.

C. National Electrical Testing Association (NETA):
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Procedures for submittals.
   1. Product Data:
      a. Grounding electrodes and connections.
      b. Starter electrical characteristics and connection requirements.
   2. Assurance/Control Submittals:
      a. Electrical System Test Reports: Submit report including the following directly to Contracting Officer from Testing Laboratory, with copy to Contractor. Prepare reports in conformance with Section 014000 - Quality Requirements.
         1) Summary of project.
         2) Description of equipment tested.
         3) Description of test.
         4) Test results.
         5) Conclusions and recommendations.
         6) Appendix, including appropriate test forms.
         7) List of test equipment used and calibration date.
         8) Signature of responsible Testing Laboratory Officer.
      b. Certificates: Manufacturer's certificate that each Product specified meet or exceed specified requirements.
      c. Qualification Documentation: Submit documentation of experience indication compliance with specified qualification requirements.

B. Section 017704 - Closeout Procedures and Training: Procedures for closeout submittals.
   1. Project Record Documents: Accurately record the following.
      a. Locations of components and grounding electrodes.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing Work of this Section with minimum 5 years documented experience.

B. Regulatory Requirements:
   1. Products: Listed and classified by Underwriters Laboratories, Incorporated as suitable for the purpose specified and indicated.
   2. Work herein shall conform to all applicable laws, ordinances and regulations in accordance with the latest applicable requirements of:
      a. National Electrical Manufacturer’s Associates.
      b. Standards of National Fire Protection Association (NFPA 72, 90A and 101).
      c. Underwriter’s Laboratories.
      d. Occupational Safety and Health Agency Standards.
      e. Illuminating Engineering Society Handbook.
      f. The International Existing Building Code.
      g. The International Electrical Code.
      h. ASHRAE Standard 90.1 – 2007.
      i. The International Energy Conservation Code.

1.5 BASIC ELECTRICAL METHODS

A. Drawings are schematic and diagrammatic. Use judgment and care to install electrical Work to function properly and fit within building construction and finishes. Electrical conductors, conduit, components, not shown or specified, which are required for any device or system to produce a complete and operative system are required to be furnished and installed.

B. Exact location of outlets are determined from dimension on Drawings, manufacturer's shop drawings, or as may be determined at Project Site. Do not scale Drawings for exact location of any item. Verify item mounting heights as required by project conditions prior to rough-in.

C. Route conduits and wiring associated with new equipment and systems above ceilings, in existing chases, and concealed within building structure.

D. Surface mounted raceways or conduit permitted only at locations indicated on Drawings.

E. Circuit grouping, conduit or cable runs and home runs are indicated with number of conductors shown in each raceway to clarify operation and function of various systems. Provide proper number of conductors and conduits or cables to provide operative system as indicated on Contract Documents. Do not regroup any feeder circuits, branch circuits, home runs, and zone alarms at any point, from that shown on Contract Documents. Each conduit run shall contain no more than (6) current carrying conductors.

F. Branch and home run circuits are indicated as 2, 3, or 4 wire circuits unless otherwise noted. Do not connect two ungrounded conductors to same circuit breaker/fused switch in any panel. Circuit runs consist of a maximum of five conductors; 3 phase conductors, 1 neutral conductor, and 1 equipment ground conductor, unless otherwise noted. Do not splice branch circuit conductors in any panels, safety switches, or circuit breakers in separate enclosures.

G. The sharing of neutral conductors for multiwire branch circuits is prohibited. All branch circuits shall contain individual neutrals.

H. Proposed equipment, switches or devices, shown mounted on and/or adjacent to equipment, which if installed, would impair proper operation of existing or new equipment, shall be removed and relocated by Contractor as required so equipment will function properly. Notify Contracting Officer immediately if any such condition exists.

I. Seal and make permanently watertight penetrations by electrical raceways or equipment through ceilings, walls or floors.
   1. Seal penetrations in non-fire rated ceilings, walls or floors material specified in Section 079200 – Joint Sealants.
   2. Seal penetrations in fire rated walls with material specified in Section 078400 - Firestopping.

J. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A, and NFPA 70.

K. Install equipment and materials to provide required maintenance and code working clearance for servicing and maintenance. Coordinate final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow required space for removal of parts that require replacement or servicing.

L. Remove existing equipment, lighting fixtures, switches, and receptacles as required to facilitate proposed installation and as specified in Section 024119 - Selective Structure Demolition. Remove existing wiring and conduit serving items to be removed. Conduit in inaccessible areas shall be cut off below finished surfaces and existing surface patched to match existing. Provide blank plates on existing flush mounted outlet boxes that will be abandoned. Remove all abandoned conductors from raceways.

M. Refer to section 015000 – Temporary Facilities & Controls for special requirements relating to facilities leased by USPS.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING

A. Grounding System Resistance: Five ohm.

B. Rod Electrodes:
1. Material: Copper.
2. Diameter: 3/4 inch.
3. Length: 10 feet.

C. Mechanical Connectors: Bronze.

D. Electrode Conductor:
1. Material: Bare stranded copper.
2. Foundation Electrodes: As specified on drawings.
3. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

2.2 HANGERS AND SUPPORTS

A. Product Requirements: Furnish and install approved materials, sizes, and types of anchors, fasteners, and supports to carry loads of equipment and conduit, including weight of wire in conduit plus 300 pounds.

B. Materials and Finishes: Corrosion resistive.

C. Anchors and Fasteners:
1. Steel Structural Elements: Beam clamps and welded fasteners.
2. Concrete Surfaces: Self-drilling anchors and expansion anchors.
3. Hollow Masonry, Plaster, and Gypsum Board Partitions: Toggle bolts and hollow wall fasteners.
4. Solid Masonry Walls: Expansion anchors.
5. Sheet Metal: Sheet metal screws.
6. Wood: Wood screws.

2.3 ELECTRICAL IDENTIFICATION

A. Nameplates:
1. Engraved three-layer laminated phenolic plastic, white letters on black background.
2. Locations:
   a. Each electrical distribution and control equipment enclosure.
   b. Communication cabinets.
   c. Terminal Cabinets.
   d. Individual motor starter.
   e. Separately enclosed circuit breakers.
   f. Panelboards
   g. Transformers.
   h. Pull boxes.
   i. Lighting contactor/control panel enclosure.
   j. Relays.
   k. Switches and disconnects.
3. Letter Size:
   a. Use 1/8 inch letters for identifying individual equipment and loads.
   b. Use 1/4 inch letters for identifying grouped equipment and loads.

B. Wire and Cable Markers:
   1. Description: Cloth tape or tubing type wire markers.
   2. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.
   3. Identification:
      a. Power and Lighting Circuits: Branch circuit or feeder number indicated on Drawings.
      b. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on Drawings.
      c. Communications Cable: Per section 170500.

C. Conduit Markers:
   1. Underground conduit routings shall be marked utilizing magnetic marker tape set atop of the entire conduit run.
      a. Underground-Type Plastic Line Marker: Manufacturer's standard detectable permanent, bright colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide by 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable. Locate tape 12 inches above top of conduit..

D. Arc Flash warning Signs: Furnish signs in accordance with NEC Article 110.16, warning of potential arc flash hazard and requiring suitable Personal protective equipment. Locate and install signs per INSTALLATION Section of this specification.

2.4 MOTOR STARTERS, CONTROLS, AND CONNECTIONS TO MECHANICAL EQUIPMENT

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:
   1. Allen-Bradley Company, Milwaukee, WI (414) 382-2000.
   2. Cutler-Hammer Eaton Corp, Milwaukee, WI (800) 833-3927.
   3. Square D Company, Palatine, IL (847) 397-2600.
   4. General Electric Company, Plainville, CT (860) 747-7111.
   5. Siemens Energy and Automation, Alpharetta, GA (800) 964-4114.
   6. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Motor Starters:
   1. Provide manual, single phase, 120/277V, toggle type, motor rated switches with thermal overload element (sized at 115 percent of full load current) for fractional horsepower motors not requiring automatic control interfaces.
   2. Provide across-the-line, AC magnetic motor starters in applications where controls other than manual on and off are involved. Motor starters shall be UL labeled. Provide starters with the following features:
      a. Rating for the voltage and current imposed.
      b. Enclosure for the application usage: NEMA 1 for dry, indoors, NEMA 3R for outdoors, etc.
      c. Control circuit voltage and amperage to match coil voltage and ratings of control apparatus.
      d. Control transformers with primary and secondary fusing for control circuits, as required.
      e. Overload elements for every conductor leg above ground. Elements are to be "thermal alloy" type, resettable and properly sized to motor nameplate rating. Elements located near boilers, heat strips, duct heaters or other heat sources or where heating by conduction or radiation can occur, shall be ambient temperature compensated types.
      f. Adjustable phase loss/phase reversal protection (0-15 seconds), factory set at 7 seconds and a minimum of two field convertible auxiliary contacts.

g. Cover-mounted control switch is to be a “start-stop” or “hand-off-auto” type with “running” and “auto” pilot lights, as required by the control sequence. A suitable reset device for manually resetting overcurrent trip shall be provided.

3. Magnetic starters for motors 10 hp or less shall be connected to automatically return the motor to service after a power interruption. Starters for motors over 10 hp shall be equipped with time delay relays so that after a power resumption and after a preset delay of 0-30 seconds, the motor shall automatically be returned to service.
4. Combination magnetic motor starter/fused disconnect unit shall be utilized wherever possible.

C. Furnish and Install the Following:
1. Conduit, wiring and electrical connections to motors, safety switches, starters, relays, electrical interlock circuits, valves, unit heaters, fan coil units, air handling units, and other similar equipment, required for complete and ready for operation. Coordinate with and review other sections of the specifications describing electrical equipment in order to fully understand the wiring requirements.
2. Starters as indicated on Drawings except factory provided starters such as those physically mounted on the unit or any piece of equipment where starter is furnished as an integral part of the equipment.
3. Electrical line voltage control components and installation as specified in Division 16 Sections.
4. Furnish and install low voltage (below 50 volts) control wiring as indicated on Drawings using metallic conduit and No. 12 type THHN wire, minimum.
5. Thermostat and special wire other than building wire.

D. Refer to Drawings for quantity and size of motor starters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 - Execution: Verification of existing conditions before starting work.

B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.

C. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.

D. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the United States Postal Service.

3.2 INSTALLATION - GROUNDING AND BONDING

A. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.

B. Provide grounding well pipe with cover at rod locations where indicated. Install well pipe top flush with finished grade or surface.

C. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing, building steel above grade and metallic cold water pipe.

D. Provide bonding and grounding in conformance with NFPA 70.

E. Equipment Grounding Conductor: Provide separate, insulated conductor within all lighting and power raceways. Terminate each end on suitable lug, bus, or bushing.

F. Testing and Inspection:
1. Inspect and test in accordance with NETA ATS, where applicable.
2. Perform inspections and tests listed in NETA ATS, Section 7.13.
3. Test ground resistance of system with ground resistance tester. The resistance of the grounding system shall not exceed 5 ohms. Where tests show resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, but driving additional ground rods; then retest to demonstrate compliance. Install rods at least 8 feet apart.
4. Method for testing individual ground rods and overall grounding system shall be accomplished by the three point method per military handbook 419. Test probes shall be placed minimum of 30 feet and 60 feet from rod being tested. Furnish written report of all test results for all ground rods.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Install products in accordance with manufacturer's published instructions.

B. Furnish and install anchors, fasteners, and supports in accordance with NECA SI.

C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

D. Do not use spring steel clips and clamps.

E. Do not use powder-actuated anchors.

F. Obtain permission from structural engineer before drilling or cutting structural members.

G. Fabricate supports from structural steel angle or structural steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

H. Install surface-mounted cabinets and panelboards with minimum of four anchors.

I. In wet and damp locations use structural steel channel supports to stand cabinets and panelboards one inch off wall.

J. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

3.4 INSTALLATION - ELECTRICAL IDENTIFICATION

A. Install nameplate parallel to equipment lines.

B. Secure nameplate to equipment front using stainless steel screws. Use minimum two screws at each end of nameplate.

C. Secure nameplate to outside surface of door on panelboards and switchboards.

D. Install Arc Flash Warning Signs on switchboards, paperboards, control panels, meter socked enclosures, and motor control centers likely to require examination, adjustment, servicing, or maintenance while energized. Locate sign so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

3.5 INSTALLATION – MOTOR STARTERS. CONTROLS, AND CONNECTIONS TO MECHANICAL EQUIPMENT

A. Verify and check equipment manufacturer's nameplate and installation instructions to obtain exact location of outlets for equipment before installation.

B. Wire and connect line voltage controls in accordance with approved wiring diagrams. Provide line voltage interlock and control wiring as indicated on Drawings using conduit and No. 12 type THHN wire.

3.6 FIELD QUALITY CONTROL - ELECTRICAL TESTING AND INSPECTION

A. Section 014000 - Quality Requirements: Field testing and inspection.

B. Section 160800 - Commissioning of Electrical Systems: Requirements related to Division 26 Commissioning

C. Conduct testing to Determine that Electrical Equipment and Systems:
   1. Are in conformance with Contract Documents and applicable reference standards.
   2. Is properly installed without damage due either to installation or shipment.
   3. Operate correctly, meet design intent, and are performing at optimum level, in safe manner.

D. Provide a complete written record of operational values to be used as a baseline for future operational testing.

E. Instrumentation:
   1. Provide calibration program that assures applicable test instrumentation is maintained within rated accuracy and directly traceable to National Bureau of Standards.
   2. Calibrate instruments in accordance with following frequency schedule:
      a. Field Instruments:
         1) Analog - 6 months maximum.
         2) Digital - 12 months maximum.
      b. Leased Specialty Equipment: 12 months. (Where accuracy is guaranteed by lessor.)
   3. Dated Calibration Labels: Visible on test equipment.
   4. Keep records current; show date and result of instruments calibrated or tested.
   5. Maintain current instrument calibration instruction and procedure for each test instrument.
   6. Calibrating Standard: Higher accuracy than that of instrument being calibrated.

F. Regulatory Requirements:
   1. Safety Practices: Include, but not limited to, the following requirements:
      a. Occupational Safety and Health Act of 1970 - OSHA.
      b. Accident Prevention Manual for Industrial Operations, Seventh Edition, National Safety Council, Chapter 4.
      c. Applicable State and Local Safety Operating Procedures.
      d. NETA Safety/Accident Prevention Program.
      e. United States Postal Service Safety Practices.
      f. NFPA 70E - Electrical Safety Requirements for Employee Workplace.
      g. American National Standards for Personnel Protection, ANSI Z244.1.
   2. Perform tests with apparatus de-energized except where otherwise specifically required herein.
   3. Testing Laboratory: Provide a designated safety representative present at Project Site and supervise safety operations.
   4. Power Circuits: Conductors shorted to ground by a hot line grounded device approved for the purpose.
   5. Do not proceed until safety representative has determined that it is safe to do so.
   6. Testing Laboratory: Provide sufficient protective barriers and warning signs to conduct specified tests safely.

G. Tests and inspections include, but are not limited to the following:
   1. Proper operation of lights and equipment.
   2. Continuity of raceway system.
   3. Insulation leakage and impedances.
   4. Ground system resistance.
   5. Elimination of reverse rotation and single-phasing of motors.
   6. Sub-system tests indicated in other Sections.
   7. Proper operation of fire alarm system specified in Section 183100.

H. Load balance all electrical phases, at device, panels, and switchboards.

I. Perform electrical system testing and inspection as specified in each related Section and as specified in this Section.

END OF SECTION

SECTION 16519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:
1. Building wire and cable.
2. Branch-circuit cable.
3. Wiring connectors and connections.
4. Drop cords.

B. Related Documents: The Contract Documents, as defined in Section 011000 - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other documents.

C. Related Sections
1. As specified in Section 160500 - Common Work Results for Electrical.

1.2 REFERENCES

A. As specified in Section 160500 - Common Work Results for Electrical

1.3 SUBMITTALS

A. As specified in Section 160500 - Common Work Results for Electrical.

1.4 QUALITY ASSURANCE

A. As specified in Section 160500 - Common Work Results for Electrical.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Transport, handle, store, and protect products.

B. Deliver in accordance with NEMA WC 26.

PART 2 - PRODUCTS

2.1 BUILDING WIRE AND CABLE

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:
1. Alcan Cable, Atlanta, GA (770) 392-2376.
2. Anixter, Inc., Skokie, IL (800) ANIXTER.
3. General Cable, Highland Heights, KY (800) 526-4391.

4. General Electric, Plainville, CT (860) 747-7111.
5. Okonite, Ramsey, NJ (201) 825-0300.
6. Southwire Company, Carrollton, GA (800) 444-1700.
7. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Description: Single conductor insulated wire.

C. Conductor: Copper.

D. Insulation Voltage Rating: 600 Volts.

E. Insulation: NFPA 70, Type THHN/THWN or Type XHHW-2

F. Multiconductor cable: Not Used.

2.2 WIRING CONNECTORS

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:
1. Buchanan Construction Products, Hackettstown, NJ (800) 610-5201.
2. Thomas and Betts, Memphis, TN (800) 695-1901.
3. 3M, St. Paul, MN (800) 364-3577.
4. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Compression Connectors; Conductor sizes #12 through #6 AWG:
1. Buchanan: 2006S or 2011S.
2. Thomas and Betts
3. 3M

2.3 DROP CORDS

A. Description: Continuous length of cable with 20 Amp, 120 Volt, locking blade type connector body at one end as indicated on Drawings. Secure cable at both ends with wire type stainless steel cable grips to prevent transmission of tension directly to conductors or terminal screws.

B. Junction Box: Furnished and installed flush with ceiling anchored to building structure for fastening of uppercord grip.

C. Cable: Type SO 600 volt flexible cord with three #12 stranded wires.

D. Connector Body: Single 20 Amp, 120 volt, grounding receptacle of twistlock type at one end and straight blade type at other end that grips on cable insulation and is manufactured for use with wire cable grips. Furnish and install drop cords in length required for a receptacle height of 6 feet 8 inches above finished floor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 160500 - Common Work Results for Electrical.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

A. Wiring methods
   1. Concealed Dry Interior Locations: Use building wire, Type THHN/THWN or Type XHHW-2 insulation in metallic raceway or MC multiconductor cable.
   2. Exposed Dry Interior Locations: Use building wire, Type THHN/THWN or Type XHHW-2 insulation in metallic raceway or MC multiconductor cable.
   3. Above Accessible Ceilings: Use building wire, Type THHN/THWN or Type XHHW-2 insulation in metallic raceway or MC multiconductor cable.
   4. Wet or Damp Interior/Exterior Locations: Use only building wire, Type THHN/THWN or Type XHHW-2 insulation in raceway.
   5. For underground feeders: Use USE or RHW conductor in PVC schedule 40 conduit.

B. Install products in accordance with manufacturers published instructions and NECA SI.

C. Use stranded for all feeders and branch circuits.

D. Use stranded conductors for control circuits and final connections to all vibration equipment.

E. Use conductor not smaller than 12 AWG for power and lighting circuits.

F. Use conductor not smaller than 14 AWG for control circuits.

G. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

H. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

I. Pull all conductors into raceway at same time.

J. Use approved wire pulling lubricant for all building wire.

K. Protect exposed cable from damage.

L. Neatly train and lace wiring inside boxes, equipment, and panelboards in accordance with NECA Standards.

M. Clean conductor surfaces before installing lugs and connectors.

N. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

O. For splices and taps, use only compression connectors for copper conductors, 6 AWG and larger or aluminum conductors 1/0 and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

P. Use solderless pressure compression connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

Q. Use conductors rated 90 degrees C, inside a ballast compartment or within 6 inches of any ballast.

R. Conductor Sizes #8 and Larger: Class B stranding.

S. Install Drop Cords to building structure at locations indicated on Drawings as indicated on Drawings.

T. The sharing of neutral conductors for multiwire branch circuits is prohibited. All branch circuits shall contain individual neutral conductors.

3.4 CONSTRUCTION

A. Interface With Other Work:
   1. Identify wire and cable using Thomas and Betts type WM vinyl markers.
   2. Identify each conductor with its circuit number or other designation indicated on Drawings in all junction, pull, terminal boxes and cabinets. Identify neutrals with common circuit numbers in all junction, pull and terminal boxes, panels and cabinets.

3.5 WIRING COLOR CODE

A. Comply with the following color code for each voltage system.

B. 208Y/120 Volt System:
   1. Phase A - Black
   2. Phase A Switch Leg - Black with “S” tag.
   3. Phase B - Red
   4. Phase B Switch Leg - Red with “S” tag.
   5. Phase C - Blue.
   6. Phase C - Switch Leg - Blue with “S” tag.
   7. Travelers - Yellow.
   8. Neutral - White.
   9. Equipment Ground - Green.
   10. Isolated Ground-Green with yellow stripes

C. 240/120 Volt System:
   1. Phase A - Black.
   2. Phase A Switch Leg - Black with “S” tag.
   3. Phase B - Orange (High-Leg)
   4. Phase C - Blue
   5. Phase C Switch Leg - Blue with “S” tag.
   6. Travelers - Yellow.
   7. Neutral - White.
   8. Equipment Ground - Green.

D. 480Y/277 Volt System:
   1. Phase A - Brown
   2. Phase A Switch Leg - Brown with "S" Tag.
   3. Phase B - Orange.
   4. Phase B Switch Leg - Orange with "S" Tag.
   5. Phase C - Yellow
   6. Phase C Switch -Leg- Yellow with "S" Tag.
   7. Travelers - Yellow with "T" Tag.
   8. Neutral - Grey.
   9. Equipment Ground - Green.

E. Use same color for same phase throughout. Use same colors for switch legs. Travelers shall be yellow. Phase rotation shall be same in all panels. Identify large cables with colored tape.

F. Provide identification tags on each conductor entering panel, switch, junction box and pull box to identify conductor.

3.6 FIELD QUALITY CONTROL

A. As specified in Section 160500 – Common Work Results for Electrical.

B. Cables, 600 Volt or less and size no. 3 or larger, shall be meggered using an industry-approved “megger with a minimum of 500 Volt internal generating voltage. All inspection, cleaning and testing procedures shall be in compliance with the recommendations and standards outlined in the “maintenance testing specifications for electrical power distribution equipment and systems”, latest edition, published by International Electrical Testing Association (NETA). Insulation resistance test values shall be no less than 250 megaohms. A typewritten report of all readings shall be prepared and submitted.

END OF SECTION

SECTION 16533

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Metal conduit.
2. Flexible metal conduit.
3. Liquidtight metal conduit.
4. Electrical metallic tubing.
5. Fittings and conduit bodies.
6. Wall and ceiling outlet boxes.
7. Pull and junction boxes.
8. Cable trays.
9. Floor boxes with covers (other uses).

B. Related Documents: The Contract Documents, as defined in Section 011000 - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other documents.

C. Related Sections:
1. As specified in Section 160500 - Common Work Results for Electrical.

1.2 REFERENCES

A. As specified in Section 160500 - Common Work Results for Electrical.

B. American Society for Testing and Materials (ASTM):
1. ASTM A 123 - Specification for Zinc (Hot-Galvanized) Coatings on Iron and Steel Products.

C. American National Standards Institute (ANSI):
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
3. ANSI C80.5 - Rigid Aluminum Conduit.

D. National Electrical Manufacturers Association (NEMA):
1. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
2. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
3. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
4. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
5. NEMA VE 1 - Metallic Cable Tray Systems.

1.3 SUBMITTALS

A. As specified in Section 160500 - Common Work Results for Electrical.

1.4 SYSTEM DESCRIPTION

A. Design Requirements
   1. Conduit Size: Latest edition of National Electrical Code - NFPA 70, unless indicated otherwise on Drawings.

1.5 QUALITY ASSURANCE

A. As specified in Section 160500 - Common Work Results for Electrical.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Transport, handle, store, and protect products.

B. Accept conduit on site. Contractor inspect for damage prior to acceptance.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

D. Protect PVC conduit from sunlight.

PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS

A. Where conduit is required by standards, codes, or required elsewhere, minimum size shall be as follows:
   1. 3/4 inch for power and branch circuit wiring, unless indicated otherwise. All homerun conduits shall be 3/4 inch minimum.
   2. 3/4 inch for communications cable, unless indicated otherwise.
   3. 3/4 inch for low voltage, control, intercom, security and communications (other than telephone) unless indicated otherwise.

2.2 METAL CONDUIT

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:

B. s: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:
   1. Allied Tube & Conduit, Harvey, IL (800) 882-5543.
   2. Wheatland Tube Co., Collinswood, NJ (800) 257-8182.
   3. Republic Wire & Cable, Rocky Mount, NC (800) 533-8198.
   4. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

C. Rigid Galvanized Steel Conduit (GRC): ANSI C80.1, UL6.

D. Intermediate Metal Conduit (IMC): UL1242.

E. Fittings and Conduit Bodies: NEMA FB1 Material to match conduit.

2.3 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:
   1. Hubbell, Millford, CT (203) 882-4800.
   2. Electriflex, Roselle, IL (800) 323-6174.
   3. 0-Z/Gedney, Farmington, CT (860) 677-5541.
   4. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Description: Thick wall, interlocked steel and aluminum construction.

C. Fittings: NEMA FB 1.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:
   1. Hubbell, Millford, CT (203) 882-4800.
   2. Electriflex, Roselle, IL (800) 323-6174.
   3. Anixter, Inc., Skokie, IL (800) ANIXTER.
   4. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Description: Thick wall, interlocked steel and aluminum construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.5 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:
   1. Allied Tube & Conduit, Harvey, IL (800) 882-5543.
   2. Wheatland Tube Co., Collinswood, NJ (800) 257-8182.
   3. Republic Wire & Cable, Rocky Mount, NC (800) 533-8198.
   4. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel set-screw type. Die-cut Zinc not permitted.

2.6 NONMETALLIC CONDUIT

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:
   1. Carlon, Cleveland, OH (800) 322-7566.
   2. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Description: NEMA TC 2; Schedule 40 PVC.

C. Fittings and Conduit Bodies: NEMA TC 3.

2.7 FITTINGS

A. Manufacturer: Raco, Inc., South Bend, IN (219) 234-7151.
   1. Subject to compliance with project requirements, one of the following manufacturers may also be provided:
      a. Steel City.
      b. 0-Z/Gedney.
   2. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Conduits 1/2 inch thru 1 inch enter junction boxes, pull boxes, panels, cabinets, and gutters, provide the following:
   1. Rigid Conduit: Raco 1222, 1223, 1224.
   2. Flexible Metal Conduit: Raco 3302, 3303, 3304, 3305, 3306, 3308.
   3. Liquidtight Flexible Metal Conduit: Raco 3511, 3512, 3513, 3541, 3542, 3543.

C. Conduits 1-1/4 inch and larger entering junction boxes, pull boxes, panels, cabinets, and gutters, provide Insulated throat type bushings.

D. Provide threaded joint connectors and malleable iron no thread compression box connectors on rigid conduit. Do not provide fittings requiring set screws or indentor type applications including BM connectors.

E. Provide only compression type couplings and connectors on EMT conduit.

2.8 CONDUIT STRAPS AND HANGERS

A. Strap Manufacturer: Raco, Inc., South Bend, IN (219) 234-7151
   1. Subject to compliance with project requirements, one of the following manufacturers may also be provided:
      a. Steel City.
      b. Unistrut.
   2. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Hanger Manufacturer: Steel City/Thomas & Betts, Memphis, TN (800) 888-0211.
   1. Subject to compliance with project requirements, one of the following manufacturers may also be provided:
      a. Unistrut.
      b. Raco.
   2. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

C. Straps: Two hole push on stamped steel straps on surface areas such as concrete, masonry, wide flange beams, columns, and wood.
   1. Rigid Conduit: Raco 2232, 2233, 2234, 2235, 2336, 2238.
   2. Electrical Metallic Tubing: Raco 2092, 2093, 2094.

D. Hangers: Lay-in pipe hanger.
   1. Conduits 1-1/4 Inch and Larger: Steel-City C-149.

E. Trapeze Hangers for Conduits Grouped Together: Hangers consisting of all thread rods sized as required and Kingdorff channel.
   1. Steel City B-909, 1/2 inch x 1-7/8 inch (12 gauge) with single bolt channel pipe straps.
   2. Steel City C-105, C-105-AL, or C-106, (no wire permitted for anchoring conduit).

2.9 SEAL-OFF AND EXPANSION FITTINGS

A. Seal-Off Fitting Manufacturer: Crouse-Hinds, Syracuse, NY (315) 477-5531.
   1. Subject to compliance with project requirements, one of the following manufacturers may also be provided:
      a. Killark.
      b. Appleton.
      c. O.Z. Gedney
   2. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Expansion Fitting Manufacturer: OZ/Gedney, Farmington, CT (860) 677-5541
   1. Subject to compliance with project requirements, one of the following manufacturers may also be provided:
      a. Crouse-Hinds.
      b. Killark.
      c. Appleton.
   2. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

C. Provide seal-off fittings where required by governing authority, code, or as indicated on Drawings.
   1. Vertical Runs: Crouse-Hinds Type EYS.
   2. Horizontal and Vertical Runs: Crouse-Hinds Type EZS.
   3. Elbows: Crouse-Hinds Type EYS.
   4. Sealing Compound: "Chico X" fiber and "Chico A".

D. Provide expansion fittings in conduits where indicated on Drawings or where required to pass through expansion joints embedded in concrete.
   1. OZ Gedney Type AX.

2.10 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
   2. Receptacle and Device Boxes - 4 inch square x 2-1/8 inch deep with raised single gang plaster ring unless indicated otherwise.
   3. Switch Boxes: 2 inch x 4 inch x 2-1/8 inch deep unless indicated otherwise.
   4. Communication Boxes: 4 inch square x 3 inch deep with raised single gang plaster ring unless indicated otherwise.

B. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.

C. Wall Plates for Finished Areas: Specified in Section 162726.

2.11 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

2.12 CABLE TRAY

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:
   1. Cable Management Solutions, Incorporated, Deer Park, NY (800) 308-6788.
   2. Chalfant Cable Trays, Cleveland, OH (216) 521-7922.
   3. GS Metals Corporation, Pinckneyville, IL (800) 851-9341.
   4. Southwire Co., Carrollton, GA (800) 444-1700
   5. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Provide factory shop drawing submittals for each type of cable tray.
   1. Show fabrication and installation details of cable tray, including plans, elevations and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths and fittings.
   2. Seismic-Restraint Details: Signed and sealed by a qualified Professional Engineer, licensed in the state where Project is located, who is responsible for their preparation.
      a. Design Calculations: Calculate requirements for selecting seismic restraints.
      b. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

C. Description: NEMA VE 1, ladder tray, wire mesh tray or ventilated bottom trough tray as indicated on drawings.

D. Material: Aluminum.

E. NEMA Load/Span Class: 20C

F. Finish: Clear aluminum.

G. Inside Width and Depth: 12 inch wide and 6 inch deep minimum unless otherwise indicated on drawings.

H. Provide with compartment dividers as indicated on drawings. Same materials and finish as tray.

I. Straight Section Rung Spacing: 9 inches on center.

J. Inside Radius of Fittings: 24 inches (minimum).

K. Provide approved manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps. Utilize cable drop-out fittings or conduit elbows where cables enter or exit the cable tray. Obtain cable tray components from a single manufacturer.

L. Engraved Nameplates: 1/2 inch high black letters on yellow laminated plastic nameplate, engraved with the following wording:

WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

2.13 FLOOR BOXES

A. Type: Modular, flush-type dual-service units suitable for wiring method used. Provide dual-service units within carpeted areas only.

B. Compartmentation: Barrier separates power and signal compartments.

C. Housing Material: Die-cast aluminum, satin-finished.

D. Power Receptacle: NEMA WD 6, Configuration 5-20R, ivory finish, unless otherwise indicated.

E. Signal Outlet: Blank cover with bushed cable opening, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified Section 160500 – Common Work Results for Electrical.

B. Verification of Conditions:
   1. Verify routing and termination locations of conduit prior to rough-in.
   2. Verify device locations and mounting heights, prior to rough-in

3.2 INSTALLATION - RACEWAYS

A. Install in accordance with the following schedule, unless indicated otherwise on Drawings: Plastic flexible PVC conduit shall not be permitted. Flexible metal conduit shall be permitted for electrical power and security wiring only and not permitted for fire alarm cables. Intermediate grade rigid conduit permitted where indicated below.
   1. Above Suspended Ceilings: Galvanized or sheradized thick wall rigid steel (GRC), or intermediate grade rigid steel (IMC), or electrical metallic tubing (EMT).
   2. Metal Stud Walls: Galvanized or sheradized thick wall rigid steel (GRC), intermediate grade rigid steel (IMC), or electrical metallic tubing (EMT).
   3. Exposed Interior Areas: Galvanized or sheradized thick wall rigid steel (GRC).

B. Install conduit in accordance with NECA "Standard of Installation."

C. Install nonmetallic conduit in accordance with manufacturer's instructions. Nonmetallic conduit shall only be used under slabs or direct buried in earth. Conduit penetrations through slab including elbows shall be galvanized rigid conduit.

D. Conduit routing indicated on Drawings are approximate locations unless dimensioned. Route parallel and perpendicular to building construction for complete wiring system regardless whether exposed or concealed.

E. Arrange supports to prevent misalignment during wiring installation.

F. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

G. Group related conduits; support using conduit rack. Construct rack using approved steel channel, and provide space on each rack for 25 percent additional conduits.

H. Fasten conduit supports to building structure and surfaces under provisions of this section.

I. Do not support conduit with wire or perforated pipe straps in any type structure. Remove wire used for temporary supports. Steel tie wire may be used to anchor conduit down to reinforcing rods in concrete encasement only.

J. Do not attach conduit or boxes to ceiling support wires. Boxes shall be independently supported.

K. Arrange conduit to maintain headroom and present neat appearance. Maintain required clearance between conduit and other piping.

L. Route all conduit whether exposed or concealed parallel and perpendicular to walls, ceilings, building structures, etc.

M. Maintain required clearance between conduit and piping.

N. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.

O. Cut EMT conduit square using saw or pipe cutter; de-burr cut ends and ream. Bring conduit to shoulder of fittings; fasten securely.

P. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

Q. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes. Use Myers hub connectors on all conduit entering top or sides of all junction boxes, pull boxes, wiring gutters, exposed to weather.

R. The number of bends per box shall comply with NFPA 70, Article 360. Conduit bends for “SCS” installation shall not exceed two 90 degree bends or exceed a total of 180 degrees of bend between pull boxes or conduit ends per ANSI/TIA/EIA/ 569-B. Pull boxes shall be sized per NEC codes per conduit installed. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate or use factory elbows for bends in metal conduit larger than 2 inch size.

S. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

T. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and expansion joints.

U. Provide suitable nylon pull string or #14 AWG THWN wire in each conduit excluding sleeves and nipples.

V. Use suitable caps to protect installed conduit against entrance of dirt and moisture. Use PVC caps.

W. Ground and bond conduit per NFPA 70.

X. Coat all metallic conduit male threads with "General Electric" RTV silicone sealer where conduit is installed in exterior areas or in contact with concrete or earth.

Y. Conduits shall be sized as indicated on Drawings. Where sizes are not indicated, conduit shall be sized per NFPA 70.

Z. Cap all upturned conduits during construction rough-in to prevent moisture or debris from entering. Use PVC caps. Pull through each and every conduit a dry swab of sufficient size to remove any and all moisture.

AA. Maximum length of flexible metal conduit (Greenfield), or flexible liquidtight shall be 5 feet.

BB. Assure ground continuity on all branch circuitry conduits with two locknuts, one inside and one outside of all boxes, cabinets and gutters for rigid conduit. One locknut inside of all boxes, cabinets, and gutters for EMT.

CC. Provide conduit supports as follows:
1. Galvanized rigid thick wall conduit (GRC), intermediate grade rigid conduit (IMC) and electrical metallic conduit (EMC) within three feet of all outlet boxes, junction boxes, cabinets, gutters, or fittings. Horizontally anchored at 10 foot maximum intervals. Other spacings indicated on Drawings.
2. Flexible metal conduit (Greenfield) and liquidtight flexible conduit (Sealtite), within 12 inches of all outlet boxes, junction boxes, cabinets, gutters, or fittings and bends or turns. Horizontally anchored at 4-1/2 foot intervals. 3/4 inch minimum size permitted.

3.3 INSTALLATION - BOXES

A. Install boxes in accordance with NECA "Standard of Installation."

B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with NFPA 70.

C. Set wall mounted boxes at elevations to accommodate mounting heights indicated or as required for specific project requirements. Orient boxes to accommodate wiring devices as specified in Section 262726.

D. Electrical boxes are indicated on Drawings in approximate locations unless dimensioned. Adjust box location up to 10 feet if required to accommodate intended purpose with no additional cost to contract. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.

E. Maintain headroom and present neat mechanical appearance.

F. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. Install pull boxes in freezer and dock area above bottom chord of structural joist. Pullboxes sized in excess of 12 inches shall be equipped with hinged and hasped covers.

G. Install outlet and junction boxes within inaccessible ceiling spaces no more than 6 inches from ceiling access panel or from removable recessed luminaire.

H. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.

I. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

J. Locate flush mounted box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening. Use approved raised gang covers in masonry and stud walls.

K. Flush mounted boxes shall not be mounted back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.

L. Secure flush mounted box to interior wall and partition studs. Accurately position to allow for surface finish thickness. Use approved stamped steel bridges to fasten flush mounting outlet box between studs.

M. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

N. Use approved adjustable steel channel fasteners spanning joist for hung ceiling outlet box.

O. Provide factory sectioned multigang box where more than one adjacent device is to be mounted together. Sectional boxes shall not be permitted.

3.4 INSTALLATION - CABLE TRAYS

A. Install trays level and plumb in accordance with manufacturer's published instructions.

B. Install metallic cable tray in accordance with NEMA VE 1.

C. Support cable trays as follows:
   1. Use anchors and fasteners as specified in Section 160500.
   2. Provide supports at each connection point and at the end of each run.
   3. Design supports including attachment to structure to carry the greater of calculated load multiplied by a factor of four or the calculated load plus 200 lb.

D. Locate cable tray with sufficient space to permit access for installing cables.

E. Make changes in directions and elevations using standard fittings. Use expansion connectors where required.

F. Ground and bond cable tray under provisions of Section 160500.
   1. Provide continuity between tray components.
   2. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
   3. Provide #2 AWG bare copper equipment grounding conductor through entire length of tray; bond to each section.
   4. Connections to tray may be made using mechanical connectors.

G. Install warning signs at 50 feet on center along cable tray, located to be visible.

3.5 FIELD QUALITY CONTROL

A. As specified Section 260500 - Common Work Results for Electrical.

B. Inspect conduit installation, types, sizes, fittings and attachment to structure.

C. Inspect box installation, locations, connection to conduit, and attachment to structure.

D. Inspect cable tray installation, locations, connection to conduit, and attachment to structure.

3.6 ADJUSTING

A. Adjust flush-mounted devices and nameplates to be plumb and flush with finished wall material.

B. Install knockout closures in unused box openings.

3.7 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish like new.

END OF SECTION

SECTION 16623

LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Lighting control system for Workroom.
   2. Lighting control system for Box Lobby.
   3. Control of Interior/Exterior Lighting.
   4. Occupancy sensors.

B. Related Documents: The Contract Documents, as defined in Section 011000 - Summary of Work, apply to the work of this section. Additional requirements and information necessary to complete the work of this section may be found in other documents.

C. Related Sections:
   1. As specified in Section 160500 – Common Work Results for Electrical.
   2. Section 019113 - General Commissioning Requirements.
   3. Section 160800 - Commissioning of Electrical Systems.

1.2 REFERENCES

A. As specified in Section 160500 – Common Work Results for Electrical.

B. National Electrical Manufacturers Association (NEMA):
   1. NEMA ICS 1 - General Standards for Industrial Control and Systems.

C. U.L. Standards:
   1. UL 916 Energy Management Equipment

1.3 SUBMITTALS

A. As specified in Section 160500 - Common Work Results for Electrical.
   1. Product Data: Data for each component of the lighting control system indicating electrical characteristics and connection requirements.
      a. Lighting Control Panels and Components
      b. Low Voltage Relays.
      c. Digital Control Switch
      d. Automatic Control Switch
      e. Occupancy Sensors.
      f. Software.
   2. Shop Drawings: Indicate electrical characteristics and connection requirements, including layout of completed assemblies, interconnecting cabling, dimensions, and power requirements.
   3. Assurance/Control Submittals:
      a. Certificates: Manufacturer's certificate that Products and components meet or exceed specified requirements.
      b. Qualification Documentation: Submit documentation of experience indicating compliance with specified qualification requirements.

B. Section 017704 - Closeout Procedures and Training: Procedures for closeout submittals.
   1. Project Record Documents: Accurately record the actual locations of Products.
   2. Operating Instruction: Document training by furnishing a sign-in sheet with a description on the training provided, instructors name and organization and those who received training. Refer to 017704 1.3, 1.4 and 1.5 for more specific training.

1.4 SYSTEM DESCRIPTION

A. It is the intent of this section of specifications to provide an integrated, energy saving, digital lighting control system including lighting control panel, mechanically held low voltage relays, components, etc. from a single manufacturer.

B. The workroom lighting system shall be designed to achieve the required lighting group levels as shown on the drawings.

C. The functional characteristic of each fixture within the workroom and enclosed platform shall be as follows:
   1. Lamp and ballast combinations within individual fixtures, groups of fixtures or at every other fixture shall be controlled as zones to achieve the required lighting levels under different lighting conditions. Control solutions such as turning off every other fixture or row of fixtures are acceptable.
   2. All fixtures shall be controlled by mechanically held, low voltage relays. In the event that the control panel fails, the relays shall remain in their current state and shall have the capability to be manually controlled at the control panel.

D. The workroom lighting shall be divided into zones to allow for turning lights off in areas that are not active or during scheduled “lights off” times. Each zone shall be wired to a pilot lighted low voltage switch on the wall adjacent to the zone, that overrides zone timers and controls. When the button is pushed, high level lighting should come on for a period of three (3) hours.

E. The lighting control panel will “stand alone” and control the time schedules for all zones that are connected. The lighting control panel shall communicate, log and furnish information about the operational characteristics of the system.
   1. There will be available to the occupants of the space, one or more manual buttons that will allow the occupants to override the control sequence for three (3) hours for maintenance, special schedules, cleaning, etc. The manual override system will only be for the zone that the buttons are located in, not for multiple zones. When the time has elapsed, the fixtures will return to their normal programmed state.
   2. Some of the lights within each zone shall blink, or give other visual warning approximately 5 minutes before they are about to time out. When the lights are not in the override condition, as a maintenance aid for troubleshooting, there shall be a green light at each relay within the control panel which is illuminated in order to show that the lights are not in the manual override state.
   3. The lighting control panel shall configure/ reconfigure zones, set up schedules, and control groups of light fixtures/lamps via low voltage digital relays.

F. The control of the interior lighting shall be integrated within the workroom digital lighting control system. Interior lighting shall be energized by low voltage digital and/or automatic control switches and de-energized by time control functions.

G. The control of the exterior lighting shall be integrated within the digital lighting control system. Exterior lighting shall be energized by photo-sensor(s) and de-energized by time control functions.
   1. The control of the exterior and building mounted signs shall operate similar to the exterior lighting control scheme, but shall utilize independent time schedules.

H. Box Lobby Control System Performance Requirements:
   1. 24 hour Box Lobby lighting shall be controlled through the low voltage relay system with an occupancy sensor override.
   2. All other Box Lobby spaces shall have manual on/off controls.

1.5 QUALITY ASSURANCE

A. As specified in Section 160500 – Common Work Results for Electrical.

B. Single Source: Provide digital controllers, control relays, photocells, selector switches, time clocks, manual or digital override timer switches, control wiring, and accessories from integrated system supplier.

C. Qualifications:
   1. Manufacturer: Company specializing in manufacturing Products specified with minimum 5 years documented experience.
   2. Installer: Company specializing in performing the Work of this Section with minimum 5 years documented experience.

D. Regulatory Requirements:
   1. Conform to requirements of NFPA 70 and NFPA 101.
   2. Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.
   3. Comply with NEC, NEMA and FCC Emission requirements for Class A applications.
   4. UL Approvals: Relay panels and accessory devices are to be UL listed under UL 916 Energy Management Equipment. Configured to order or custom relay panels shall be UL Listed under UL 508, Industrial Control Panels.

E. Testing:
   1. Component Pretesting: All component and assemblies are to be pretested and burned-in prior to installation.
   2. System Checkout: A factory trained technician shall functionally test each component in the system after installation to verify proper operation and confirm that the panel wiring and addressing conform to the wiring documentation. Submit check-out memo from factory representative.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Transport, Handle, Store, and Protect Products.

B. Store products in clean, dry area; maintain temperature to NEMA ICS 1 requirements.

1.7 WARRANTY AND TECHNICAL SUPPORT

A. Digital control system manufacturer shall provide two (2) years of technical support to the end users. Services shall include the reconfiguration of zones, schedule changes, additional training, etc., as needed, free of charge. This support may be provided in person, by phone, or through web-based communication tools.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with project requirements, manufacturers offering products which may be incorporated in the Work include the following:
   1. Encelium Technologies, Inc., Philadelphia, PA (267) 286-0336
   2. General Electric Company, Plainville, CT (800) 626-2000.
   3. Hubbell Building Automation, Inc, Austin, TX (888) 698-3242.
   4. Lightolier, Fall River, MA (508) 679-8131.
   5. Lighting Control & Design, Glendale, CA (800) 345-4448
   6. Lutron Electronics,Co. Coopersburg, PA (800) 523-9466
   7. Novitas, Culver City, CA (310) 568-9600.
   8. Tork, Mount Vernon, NY (914) 664-3542.
   9. Watt Stopper, Santa Clara, CA (800) 879-8585.

B. Section 016000 - Product Requirements: Product options and substitutions. Unless otherwise noted,. substitutions are permitted.

C. INTERIOR WORKROOM LIGHTING CONTROLS (no substitutions)
   1. Encelium
   2. General Electric.
   3. Lutron.
   4. Lightolier.
   5. Lighting Control and Design.
   6. Watt Stopper.

2.2 LIGHTING CONTROL PANEL(S)

A. Provide lighting control panel capacities as indicated on the drawings. Panel(s) shall be of modular construction and consist of the following components:
   1. Enclosure/Tub shall be NEMA 1 as indicated on the plans, sized to accept an interior with 1-8 relays, 1-24 relays and six (6) four pole contactors, or 1-48 relays with six (6) four pole contactors.
   2. Cover shall be configured for surface or flush (as indicated on drawings) wall mounting of the panel. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
   3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (class 1) wiring from low voltage (class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable, mechanically held, latching type relays. The panel interiors shall include the following features:
      a. Provision for one or two optional control and automation cards.
      b. Removable, plug-in terminal blocks with screw-less connections for all low voltage terminations.
      c. Individual terminal block, override push button, and LED status light for each relay
      d. Switch inputs associated with each relay and group channel shall support two or three wire, momentary or maintained contact switches.
      e. Isolated contacts within each relay shall provide true relay state to the electronics. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems.
      f. Automatic sequenced operation of relays reduces impact on the electrical distribution system when large loads are controlled simultaneously.

g. Group, channel, and pattern control of relays shall be provided through a simple button-press interface within the panel. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and channel override push buttons and LED displays.
h. Relay group status for each channel shall be provided through bi-color operation of the LED indicators. Solid red indicates that all relays in the group are on, solid green indicates that the group is in a mixed state, and blinking green indicates that the relays have blink warned and are currently timing out.
i. Each relay and channel terminal block shall provide a 24V pilot light signal. It shall be possible to configure the system for support for any Class 2 pilot light voltage with the use of an auxiliary power supply.
j. Single pole, mechanically held relays with modular plug-in design. Relays shall provide the following ratings and features:
k. Electrical:
    1) 30 amp ballast at 277V
    2) 20 amp tungsten at 120V
    3) 1.5 HP motor at 120V
    4) 14,000 amp short circuit current at 277V
l. Mechanical:
    1) Individually replaceable, ½" KO mounting with removable Class 2 wire harness
    2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel
    3) Dual line and load terminals each support two #14 – #12 solid or stranded conductors
    4) Tested to 300,000 mechanical on/off cycles
    5) Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
m. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

4. The Dataline wire will be supplied by the equipment manufacturer and will include the manufacturer's name, catalog number printed on the wire jacket. The contractor, at its own expense, will replace an improper dataline wire.
5. Panel(s) shall be digitally addressed and support bi-directional communication between [each other and] other intelligent field devices specified elsewhere.
6. Basis of Design: Wattstopper.

2.3 ADVANCED COMMUNICATIONS, INTEGRATION AND PC CONNECTIVITY

A. Provide an advanced communications network that supports optional features (not specified herein) such as PC connectivity, TCP/IP connections, advanced programming system documentation, enhanced diagnostics, historical and runtime accumulation, and graphic programming and control.
1. The system shall support the following advanced operating scenarios:
    a. Adjustable override periods for after hour use based upon the day of the week.
    b. Preemptive override before OFF to prevent blink warning and to start a new override time delay.
    c. Allow common areas to remain ON when specific relays in a panel are ON. Egress timer starts a countdown when the last watched relay turns OFF.
    d. Master Switch Control with blink option to provide a blink warning and five minute countdown for occupants when a master switch is turned OFF
2. Communications
    a. Panel(s) shall support RS232 twisted pair and optional RS-485 connections. Either protocol may be used for programming, monitoring, and control. The dataline shall allow

simultaneous operation of multiple communications access points to support multiple operator terminals and communications with other building automation systems.

b. Panel(s) shall be capable of stand-alone automatic operation and the network shall achieve full distributed processing.

c. All programming shall be accomplished with a Windows based PC running compatible software package.

3. Hardware Features
   a. Each communication control card shall be capable of providing all logic, control, runtime data, status information, and communications functions for up to 48 relays in a panel.
   b. EEPROM power loss memory and clock holdup time: 30 days
   c. Self-diagnostics: Automatic diagnostics on all memory, input/output card modules, relays, and dataline.
   d. Clock: Digital with time, day of week, and date. Automatic leap year compensation. Programmable Daylight Savings Time and Standard Time adjustment.
4. Time Delay / Blink Warning
   a. Used during unoccupied periods, assignable for each relay.
      1) Time delays from 2 to 1,440 minutes.
      2) Blink Warning: 1-second OFF blink followed by a 5 minute grace period before OFF.
      3) An optional second blink warning one minute before OFF.
   b. Operates automatically for all scheduled OFFs and time delay overrides.
   c. Occupant overrides may be entered before the blink warning to prevent a scheduled blink and shutdown.
5. Analog Photo-Sensor Configuration
   a. Enable any group switch card input (eight per group switch card) to act as an analog input into the panel for use with photocells or other analog devices
   b. Select the photocell from list of available types including:
      1) Outdoor, 0 - 200 foot candles
   c. Establish trigger parameters for each analog input with:
      1) Separate on and off set points
      2) Separate on and off time delays
      3) Load to be controlled by the input
6. A total of 32 sets of trigger parameters may be established per panel
7. Analog Photo-Sensor Monitoring
   a. Actual foot candle light levels per photocell and the current trigger state of the loads may be read using the Operators Software specified in section 2.21.
8. Telephone Override
9. Each relay shall respond to up to eight different telephone override codes. Maximum of 9999 telephone codes can be programmed.
10. Runtime Counters for Each Relay
    a. Cumulative runtime (up to 31 years) and number of cycles (up to 17 million) since last reset. User re-settable.
    b. Daily runtime for the current day and each of the prior 40 days.
    c. Monthly runtime for current and 14 prior months.
11. Activity Logs
    a. Store previous relay events including the time, new state, and cause for the change in state.
    b. Annunciate over the dataline and RS232 port when the table is 25%, 50%, 75% and 100% full.

2.4 EIGHT CHANNEL DIGITAL PHOTOCONTROL MODULE

A. Provide weatherproof Class 2 photo-sensor for measuring exterior light levels. The photo-sensor shall be mounted facing north as indicated on the plans. The photo-sensor shall be connected to a photocontrol module mounted on the DIN rail inside the low voltage section of a lighting control panel and connected to the dataline communications wire.

2.5 DIGITAL DATALINE SWITCHES

A. Intelligent digital switching shall be provided operating on the dual twisted pair communication wire. Switches shall be available in single, dual, quad, or octal (1-button, 2-button, 4-button, or 8-button) designs. The single, dual, and quad devices shall mount in a standard single-gang box, the octal version in a two-gang box.

1. Each button shall be individually programmable. Programming of buttons shall not require the use of a computer or other programming device. It shall be possible to assign relays or channels to buttons using a simple button press interface. Each button can control any one of the following options:
   a. Any individual relay in any single panel.
   b. Any group of relays in any single panel.
   c. Any group of relays in the system (via network clock, Automation Appliance, or WinControl software package).
2. For applications that require pattern switching, buttons shall function as a scene control using an ON/OFF/Not Controlled pattern of relays instead of the normal All ON/OFF.
3. Switches shall be constructed of non-breakable Lexan on all exposed parts and shall include a matching screw-less Lexan wall plate.
4. Individual buttons shall have a removable clear cover to allow standard 9 mm (3/8 inch) labeling tape to be used to identify the controlled loads.
5. Each switch shall use a bi-color LED pilot light for the individual buttons to indicate status of the controlled relay or group of relays. LED indications are Red for All ON, Green for Mixed State (some relays in the group ON and others OFF), and No LED for All OFF.
6. Switch LED pilot lights shall flash green to indicate impending off sweep during the five-minute grace period following blink warning of the lights. Once the button is pressed, the LED will change to Red to acknowledge the occupant's override command to keep lights ON.
7. Multiple dataline switches programmed to control the same relay or relay group shall indicate the same status automatically.
8. Each switch shall also include a locator light illuminating the switch for easy location in the dark.
9. The dual, quad, and octal switches shall all include a single master button that will override all relays controlled by the individual buttons OFF, or Restore them to their original state. Each switch's master button configuration can be altered to perform a Master ON/OFF, OFF Only, or Disabled function if desired.
10. Switches can be configured to follow a "Cleaning" scenario. This specific scenario shall prevent the cleaners from overriding OFF any relays previously turned ON by an occupant.
11. Each switch is available in a Key lock override version. Once a key is inserted, the individual buttons will function for five minutes.

2.6 WALL BOX OCCUPANCY SENSOR

A. Provide flush mounted, wall box type occupancy sensor with the following features:

1. The Occupancy Sensor Switch shall be a designer-style, multiple-detection technology, universal voltage occupancy sensing wall switch.
2. Sensor shall be designed to accept and control universal voltage (120VAC to 277VAC, 60Hz.) and rated to control up to 1000-watt lighting loads.
3. Sensor shall be a two-wire switch capable of handling the following loads:
   a. Quartz Halogen
   b. General Inductive
   c. Cold Cathode / Neon
   d. Electronic Low-Voltage
   e. Magnetic Low-Voltage
   f. Fluorescent Non-Dimming Ballasts
4. Sensor shall have a viewing area of not less than one hundred seventy (170°) degrees at an axial distance of forty feet (40'), fifty feet (50') at 0 degrees, and shall have a total coverage area of not less than four-thousand square feet (4,000 Sq. Ft.) with an unobstructed view.

5. Device shall be supplied with color-coordinated, self-sticking masking labels that reduce the field of view to 60, 90, or 120 degrees.
6. Sensor shall utilize non-intrusive, passive detection technologies consisting of:
    a. Passive Infrared (PIR) to read and detect occupants' body heat and movement, and;
    b. Enhanced PIR with Digital Signal Processing (DSP) to read and detect occupancy throughout the entire space, and;
    c. Photo detection to sense human motion and help differentiate this signal from other sources such as hot air vents.
7. Under no circumstances shall the unit emit energy of any type into the space that can potentially interfere with electrical, electronic, or medical devices (i.e. hearing aids), etc.
8. Each unit shall provide manual on/automatic off operation and accept on/off commands from an unlimited number of multi-location 3-way Remotes.
9. Remote stations shall provide multi-location On / Off control of the switch using conventional 3-way wiring.
10. Each unit shall be capable of 4 time-out methods to adapt to the space:
    a. Manual fixed time (user definable) from 1 to 30 minutes.
    b. Auto Time Out Calibration – Conservative Mode
    c. Auto Time Out Calibration – Normal Mode
    d. Auto Time Out Calibration – Aggressive Mode
    e. In Auto Time Out Calibration Mode the unit shall automatically adapt the time out period to the occupancy patterns of the space to maximize energy savings while minimizing distraction to the user.
11. The unit shall, when manually turned off by the user, continue to monitor the space, but will not turn on the lights. User shall be able to, at anytime, override this feature by manually turning on the lights.
12. Each unit shall, at the user's discretion, be programmed (at the sensor) to automatically adapt its programming parameters to optimally set time delay according to the space's occupancy/vacancy patterns.
13. The unit's operational/parameter programming shall be accomplished with the unit installed and operational without the need to remove the unit (or its faceplate) from its installed location.
14. Each unit shall provide a LED indicator to provide indication when the sensor detects movement.
15. Device shall offer the selection of three user-programmable warning tones before automatically turning Off. The unit shall also offer the ability, to the user, to turn off warning tones.
16. Device shall mount in a single gang wallbox and be gangable with other designer-style electrical devices and faceplates.
17. Each unit shall include, a designer-style screwless, detachable color-coordinated faceplate in White, Ivory, or Light Almond.
18. The Sensor shall be UL Listed to U.S. and Canadian standards for a 120VAC to 277VAC capacity.
19. Basis of Design: Lightolier #ITS2U.

2.7 CEILING MOUNTED OCCUPANCY SENSOR

A. Provide ceiling mounted, 360 degree, type as specified on drawings occupancy sensor with the following features.
    1. The sensor shall be capable of detecting presence in the control area by detecting doppler shifts in transmitted ultrasound and passive infrared heat changes.
    2. Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either shall hold lighting on.
    3. Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.

4. Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall utilize Advanced Signal Processing that automatically adjusts the detection threshold dynamically to compensate for changing levels of activity and airflow throughout controlled space.
5. The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.
6. To avoid false ON activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
7. Sensors shall utilize SmartSet™ technology to optimize time delay and sensitivity settings to fit occupant usage patterns. The use of SmartSet shall be selectable with a DIP switch. Sensors shall have a time delay that is adjusted automatically (with the SmartSet setting) or shall have a fixed time delay of 5 to 30 minutes.
8. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
9. Sensor shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.
10. Sensor shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%. Sensors shall have standard 5 year warranty and shall be UL and CUL listed.
11. Basis of Design: Wattstopper #DT-305 or #WT-2200.

2.8 AUTOMATIC CONTROL SWITCH

A. Provide flush wall mounted automatic control switch with the following features.
1. The automatic control switch shall be a push button wall switch capable of on/off manual operation and shall also be capable of receiving automatic control signals through interrupting power to the circuit feeding the switch and load.
2. All automatic control signals to the switch shall be sent over the circuit wires feeding power to the switch and load. No additional control wiring to the switch shall be required to provide automatic signaling.
3. Control switch shall mount in a standard single gang or multi-gang wall box and shall fit behind a decorator style face plate. The control switch shall not protrude more than 1/8” from the wall and should blend in aesthetically.
4. Control switch shall have no minimum load requirement and shall be capable of switching from 0 to 1300 Watt incandescent and fluorescent @ 120 VAC - 60Hz, and 0-3000 Watt fluorescent @ 277 VAC - 60Hz
5. Control switch shall use an air gap relay for switching ballast, tungsten, general use and shall be compatible with all electronic ballasts and HID loads. Switch shall be capable of 3-way, 4-way, or multi-way switching.
6. Self-adjusting zero cross switching technology shall be used to protect from the effects of high inrush current and to increase switch/relay operation life.
7. Control switch shall have user adjustable settings for occupancy sensor/control panel operating mode, enable/disable audible beep, and enable/disable command on feature. Settings shall be made using the switch push button and configuration LEDs and shall not require the removal of the switch faceplate.
8. Lighting control panel operation shall include the capability of automatically shutting switches off, turning switches on, and delaying switches off.
9. Delay off operation shall provide a one or two second warning blink followed by a five minute delay time period before shutting off the lights. During the delay off period, the locator LED shall blink and, if enabled, an audible warning beep shall sound each minute for the first four minutes

and each five seconds during the last minute of the delay time period. The delayed shut off may be canceled by pressing the front push button.

10. The switch shall not require a neutral, simplifying installation and shall feature terminal style wiring, which makes installation easier.
11. Control switch shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%. Control switch shall be UL and CUL listed and shall have a five (5) year warranty.
12. Basis of Design: Wattstopper #AS-100.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 160500 – Common Work Results for Electrical.

3.2 INSTALLATION

A. The Lighting Control System shall be installed and wired completely as shown on the plans by the contractor, who shall make all necessary wiring connections to external devices and equipment.

B. Accurate “as-built” drawings shall be furnished by the contractor to aid the owner in programming. These should indicate the load controlled by each relay and the identification number for that relay. They should also identify the physical location of each switch connected to an input and the identification number of that input. Three sets of space plans or lighting plans shall be furnished by the contractor indicating which fixtures are controlled by each relay.

3.3 FIELD QUALITY CONTROL

A. As specified in Section 160500 - Common Work Results for Electrical.

B. Perform operational testing on lighting control system to verify proper operation and field wiring connections.

C. System Start Up and Commissioning
   1. Manufacturer shall provide a factory authorized technician to confirm proper installation and operation of all lighting control system components. The startup requirement is intended to verify:
      a. The digital switches and relay panels interact as a complete and operational system to meet the design intent.
   2. Manufacturer to provide a written statement verifying that the system meets the above requirements.

D. System Training
   1. Manufacturer shall provide factory authorized technician to train owner personnel in the operation, programming and maintenance of the lighting control system including all occupancy sensors and daylighting controls.

E. System Programming
   1. Manufacturer shall provide system programming including:
      a. Wiring documentation.
      b. Switch operation.
      c. Operating schedules.

END OF SECTION

SECTION 16726

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Wall switches.
2. Receptacles.
3. Device plates and box covers.
4. Multi-outlet surface raceway.
5. TelePower poles.

B. Related Documents: The Contract Documents, as defined in Section 011000 - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other documents.

C. Related Sections:
1. As specified in Section 160500 - Common Work Results for Electrical.

1.2 REFERENCES

A. As specified in Section 160500 - Common Work Results for Electrical.

B. National Electrical Manufacturers Association (NEMA):
1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Device -- Dimensional Requirements.

1.3 SUBMITTALS

A. As specified in Section 160500 - Common Work Results for Electrical.

1.4 QUALITY ASSURANCE

A. As specified in Section 160500 - Common Work Results for Electrical.

B. Qualifications:
1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 5 years documented experience.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:
   1. Hubbell, Inc, Milford, CT (203) 882-4800.
   2. Leviton Manufacturing, Company, Inc., Little Neck, NY (800) 824-3005.
   3. Pass & Seymour, Syracuse, NY (800) 776-4035.
   4. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Provide 20 Amp, 120/277V, heavy duty industrial specification grade, flush, single pole toggle switches with side and back wired screw terminals. All switches shall be self-grounding, equipped with grounding screws.

C. Single Pole Switch:
   1. Leviton Cat. No.1221-2.
   2. P&S Cat. No. PS20AC1I.
   3. Hubbell Cat. No. HBL1221.

D. Double Pole Switch:
   1. Leviton Cat. No. 1222-2.
   2. P&S Cat. No. PS20AC2.
   3. Hubbell, Cat. No. HBL1222.

E. Three-way Switch:
   1. Leviton, Cat. No. 1223-2.
   2. P&S Cat. No. PS20AC-3.
   3. Hubbell Cat. No. HBL1223.

F. Indicator Switch:
   1. Leviton Cat. No. 1221-PLR (Red).
   2. P&S Cat. No. PS20AC1-RPL (Red).
   3. Hubbell Cat. No. HBL1221PL (Red).

G. Locator Switch:
   1. Leviton Cat. No. 1221-LHC (Clear).
   2. P&S Cat. No. PS20AC1-CSL (Clear).
   3. Hubbell Cat. No. HBL1221IL (Clear).

H. Locking Switch:
   1. Leviton Cat. No. 1221-2LW.
   2. P&S Cat. No. PS20AC1-L.
   3. Hubbell Cat. No. HBL1221L.

I. Color: White unless indicated otherwise.

2.2 RECEPTACLES

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:

B. rements, manufacturers offering specified items which may be incorporated in the Work include the following:
   1. Leviton Manufacturing, Company, Inc., Little Neck, NY (800) 824-3005.
   2. Pass & Seymour, Syracuse, NY (800) 776-4035.
   3. Hubbell, Inc, Milford, CT (203) 882-4800.
   4. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

C. Provide duplex, heavy duty extra hard use industrial specification grade, (unless hospital grade receptacles are specified on drawings) 20 Amp, 120 Volt, 2 pole, 3 wire receptacles, self-grounding with grounding screw.

D. Duplex Convenience Receptacle (unless hospital grade receptacles are specified on drawings):
1. Leviton Cat. No. 5362.
2. P&S Cat. No. 5362.
3. Hubbell Cat. No. HBL5362.

E. GFCI Receptacle (Back and Side Wired Feed-Thru) (unless hospital grade receptacles are specified on drawings):
1. Leviton Cat. No. 6599.
2. P&S Cat. No. 2091-SHG.
3. Hubbell Cat. No. HBLGF5362.

F. Use tamper resistant receptacles were shown on drawings and as required by NEC. Use same receptacle type specified but with tamper resistant feature.

G. Color: White unless indicated otherwise.

2.3 WALL PLATES

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:
1. P&S Sierra.
2. Hubbell.
3. Leviton.
4. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Cover Plate: Non-magnetic #302 stainless steel satin finish.

C. Weatherproof Cover Plate: Gasketed cast metal with hinged gasketed device.
1. Sierra 4510 cast aluminum.

2.4 MULTI-OUTLET SURFACE RACEWAY

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:
1. Legrand/Wiremold, West Hartford, CT (800) 621-0049.
2. Section 01600 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Raceway Material: Anodized aluminum with manufacturer’s standard hardware and fittings. Length as indicated on drawings.

C. Wire: Factory pre-wired with No. 12 AWG minimum. Provide equipment grounding conductor.

D. Wiring Devices: NEMA5-20R duplex receptacles and/or telecommunication outlets. Quantity as indicated on drawings.

E. Provide single channel raceway for applications requiring power receptacles only. Provide dual channel raceway for applications requiring power receptacles and telecommunications outlets.

F. Single channel, single cover raceway.
   1. Wiremold #AL3000 Series.

G. Dual channel, single cover raceway
   1. Wiremold #AL4000 Series.

2.5 TELE/POWER POLE

A. Manufacturers: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following:
   1. Legrand/Wiremold, West Hartford, CT (800) 621-0049.
   2. Section 01600 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Raceway Material: Anodized aluminum with manufacturer's standard hardware and fittings. Length as indicated on drawings.

C. Wire: Factory pre-wired with No. 12 AWG minimum. Provide equipment grounding conductor.

D. Wiring Devices: NEMA5-20R duplex receptacles and/or telecommunication outlets. Quantity as indicated on drawings.

E. Basis of Design: Wiremold NP620 Series.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 160500 - Common Work Results for Electrical.

B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.
   1. Verify that outlet boxes are installed at proper height.
   2. Verify that wall openings are neatly cut and will be completely covered by wall plates.
   3. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on bottom.

E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

F. Connect wiring devices by wrapping conductor 2/3 of screw diameter in clockwise direction around screw terminal. Tighten screw to 12 pound-inches. Do not use spring pressure devices for wire connections.

G. Install coverplates on switch, receptacle, and blank outlets.

3.4 CONSTRUCTION

A. Interface with other work:
   1. Coordinate locations of outlet boxes provided under Section 160533 to obtain mounting heights indicated on Drawings.

3.5 FIELD QUALITY CONTROL

A. As specified in Section 160500 – Common Work Results for Electrical.

B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.

D. Verify that each receptacle device is energized.

E. Test each receptacle device for proper polarity.

F. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush, level and plumb with wall.

3.7 CLEANING

A. Section 017300 Execution: Cleaning installed work.

B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 16816

ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Fuses.

B. Related Documents: The Contract Documents, as defined in Section 011000 - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents.

C. Related Sections:
   1. As specified in Section 160500 - Common Work Results for Electrical.

1.2 REFERENCES

A. As specified in Section 160500 - Common Work Results for Electrical.

B. National Electrical Manufacturers Association (NEMA):
   1. NEMA FU 1 - Low Voltage Cartridge Fuses.
   2. NEMA KS 1 - Enclosed Switches.

1.3 SUBMITTALS

A. As specified in Section 160500 - Common Work Results for Electrical.
   1. Product Data:
      a. Switch ratings and enclosure dimensions.
      b. Fuse data sheets showing electrical characteristics including time-current curves.
   2. Assurance/Control Submittals:
      a. Certificates: Manufacturer's certificate that Products meet or exceed specified requirements.
      b. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

B. Section 017704 - Closeout Procedures and Training: Procedures for closeout submittals.
   1. Project Record Documents: Record actual locations of enclosed switches and actual fuse sizes.

1.4 QUALITY ASSURANCE

A. As specified in Section 160500 - Common Work Results for Electrical.

B. Perform Work in accordance with NECA SI.

1.5 MAINTENANCE

A. Section 017704 - Closeout Procedures and Training: Procedures for closeout submittals.

B. Extra Products: At completion of installation, deliver to Contracting Officer.
   1. Three of each size and type fuse installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Switches: Subject to compliance with project requirements, manufacturer's offering Products which may be incorporated in the Work include the following:
   1. Eaton/Cutler Hammer Corp., Pittsburg, PA (800) 525-2000.
   2. General Electric Company (800) 626-2000.
   3. Siemens Energy & Automation, Alpharetta, GA (800) 964-4114.
   4. Square D Company, Palatine, IL (800) 392-8781.

B. Fuses: Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:
   1. Cooper Industries Incorporated, Waukesha, WI (414) 524-3300.
   2. General Electric Company (800) 626-2000.
   3. Gould Shawmut, Newburyport, MA (508) 462-6662.

C. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

2.2 FUSIBLE ENCLOSED SWITCH ASSEMBLIES

A. NEMA KS 1, Type HD heavy duty, 100,000 AIC load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Cover shall be equipped with a manual defeat to allow opening by authorized personnel while energized. Handle shall be lockable in ON or OFF position. General duty rated enclosed switches must not be allowed as substitution.

B. Rating: 250 volts AC or 600 volts AC as indicated on Drawings.

C. Fuse Clips: Designed to accommodate Class R fuses.

D. Enclosures: NEMA KS 1.
   1. Interior Dry Locations: NEMA Type 1 or 12.
   2. Exterior Locations: NEMA Type 3R or 12.

E. Provide factory grounding lug and neutral block if required.

2.3 NONFUSIBLE SWITCH ASSEMBLIES

A. NEMA KS 1, Type HD, heavy duty load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Cover shall be equipped with a manual defeat to allow opening by authorized personnel while energized. Handle shall be lockable in ON or OFF position. General duty rated enclosed switches must not be allowed as substitution.

B. Rating: 250 volts AC or 600 volts AC as indicated on Drawings.

C. Enclosures: NEMA KS 1.
   1. Interior Dry Locations: NEMA Type 1 or 12.
   2. Exterior Locations: NEMA Type 3R, 12 or 4X stainless steel.

D. Provide factory grounding lug and neutral block if required.

2.4 FUSES

A. NEMA FU 1, Class RK5, dual element, current limiting, time delay, 250 volt AC or 600 volt AC as indicated on Drawings.

B. Interrupting Rating: 100,000 rms amperes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 160500 – Common Work Results for Electrical.

3.2 INSTALLATION

A. Switches:
   1. Install in accordance with manufacturers published instructions and NECA SI.
   2. Install where indicated on Drawings, where required by equipment, and where required by NFPA 70.
   3. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

B. Fuses:
   1. Install fuses in fusible switches in accordance with manufacturer's published instructions, as indicated on Drawings, or as required by loading per NFPA 70.
   2. Install fuse with label oriented with manufacturer, type, and size easily read.

3.3 FIELD QUALITY CONTROL

A. As specified in Section 160500 – Common Work Results for Electrical.

END OF SECTION

SECTION 16850

SECONDARY DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Secondary dry type two winding transformers.

B. Related Documents: The Contract Documents, as defined in Section 011000 - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents.

C. Related Sections:
1. Section 160500 - Common Work Results for Electrical.

1.2 REFERENCES

A. As specified in Section 260500 – Common Work Results for Electrical.

B. National Electrical Manufacturers Association (NEMA):
1. NEMA ST 20 - Dry Type Transformers for General Applications.

1.3 SUBMITTALS

A. As specified in Section 160500 – Common Work Results for Electrical.

B. Section 013300 - Submittal Procedures: Procedures for submittals.
1. Product Data: Outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.
2. Manufacturer's Test Reports:
a. Loss data, efficiency at 25, 50, 75 and 100 percent rated load.
b. Sound level.
3. Assurance/Control Submittals:
a. Certificates: Manufacturer's certificate that Products meet or exceed specified requirements.
b. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

C. Section 017704 - Closeout Procedures and Training: Procedures for closeout submittals:
1. Project Record Documents: Record actual locations of transformers.
2. Maintenance Data: Include recommended maintenance procedures and intervals.

1.4 QUALITY ASSURANCE

A. As specified in Section 160500 – Common Work Results for Electrical.

B. The transformers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of ANSI and NEMA.

C. Transformers shall be UL listed and bear the UL label.

D. The manufacturer shall be ISO 9000, 9001 or 9002 certified.

E. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years.

F. The transformers shall be suitable for and certified to meet all applicable seismic requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Transport, handle, store, and protect Products.

B. Deliver transformers individually wrapped for protection and mounted on shipping skids.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:
1. Eaton Corporation, Cutler-Hammer Products, Pittsburgh, PA (800) 525-2000.
2. General Electric Company (800) 626-2000.
3. Siemens Energy & Automation, Inc., Alpharetta, GA (800) 964-4114.
4. Square D Company, Palatine, IL (800) 392-8781.

B. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

2.2 TWO WINDING TRANSFORMERS

A. NEMA ST 20, factory-assembled, air cooled dry type transformers, ratings as indicated on Drawings.

B. Units shall be energy efficient, isolated, two winding, copper, constructed and tested to latest specifications of NEMA. Insulation shall be rated for 80 degrees C temperature rise with maximum cover temperature of 35 degrees C over 40 degrees C ambient. Units shall have minimum B.I.L. of 10 KV and dampening between core and case end for case mounting to floor or wall.

C. Wiring terminals shall be located where temperature under 10 percent overload conditions will not exceed 60 degrees C. Lifting means shall be mounted to core and accessible without removal of parts.

D. Units shall be as indicated with two 5 percent of four 2 ½ percent FCBN taps and two FCAN taps on the high voltage winding. Taps shall be accessible for changing with bolted links.

E. Primary and secondary connections shall be readily accessible with terminal boards and spade or pressure lugs.

F. Transformers shall be designed for continuous operation at rated KVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.

G. Where required, the transformers shall be specifically designed to supply circuits with a harmonic profile equal to or less than its K-factor rating without exceeding 80 degree C temperature rise.

H. Where required for K-Factor rating 4 or greater, the neutral bus shall be configured to accommodate 200 percent of the rated current.

I. Where required to suit manufacturer's performance requirements of equipment served, provide isolation transformers with electrostatic shielding.

J. Sound Levels: NEMA ST 20.
1. 1 to 5 KVA: 30 dB.
2. 6 to 25 KVA: 40 dB.
3. 26 to 150 KVA: 42 dB.
4. 151 top 225 KVA: 43 dB.

K. Transformers sized above 112.5 KVA shall have U.L. Class 155 insulation ratings, minimum. Installation of transformers shall comply with NFPA 70, (NEC) Article 450.21(B).

L. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap in accordance with Article 250 of NFPA 70.

M. Mounting: Suitable for wall, floor, or trapeze mounting, except transformers larger than 75 kVA, suitable for floor mounting.

2.3 ENCLOSURE

A. The enclosure construction shall be ventilated, NEMA 2 drip-proof, with lifting holes. All ventilation openings shall be protected against falling dirt. On outdoor units, provide weather shields over ventilated openings.

B. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.4 SOURCE QUALITY CONTROL

A. Production test each unit according to NEMA ST20.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 160500 – Common Work Results for Electrical.

3.2 PREPARATION

A. Provide minimum 4 inch high concrete pad for floor mounted transformers.

3.3 INSTALLATION

A. Install transformers in accordance with NECA SI and manufacturer's published instructions, as indicated and located on the drawings.
   1. Use manufacturer approved mounting brackets for transformers supported from building structure.
   2. Securely anchor transformers to concrete pad for floor mounted transformers.
   3. Provide working clearances in conformance with NFPA 70 and manufacturer’s recommendations.
   4. Provide both primary and secondary protection using fuses or circuit breakers as indicated on Drawings.

B. Set transformers plumb and level.

C. Use minimum 2 foot length flexible conduit for connections to transformer case. Make conduit connections to side panel of enclosure. Flexible conduit specified in Section 160533.

D. Mount transformers on vibration isolating pads suitable for isolating transformer noise from building structure.

E. Provide grounding and bonding as specified in Section 160500.

F. Furnish and install engraved plastic nameplates as specified in Section 160500.

G. Furnish and install seismic restraints designed for type of mounting used.

3.4 FIELD QUALITY CONTROL

A. As specified in Section 160500 – Common Work Results for Electrical.

B. Section 014000 - Quality Requirements: Field testing and inspection.

C. Check for damage and tight connections prior to energizing transformer.

D. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION

SECTION 16860

SURGE PROTECTIVE DEVICES (SPDS)

PART 1 - GENERAL

1.1 SUMMARY

A. This section describes the materials and installation requirements for surge protective devices (SPD) for the protection of all power and communications circuits. Provide and install materials, labor and auxiliaries required to furnish and install complete surge suppression for the protection of building electrical and electronics systems from the effects of induced transient voltage surge and lightning discharge as indicated on drawings.
   1. Provide surge suppression devices for the following equipment:
      a. Each main electrical service switchboard as indicated for on drawings.
      b. Distribution and branch panels as indicated for on drawings.
      c. All electronic communications equipment installed including but not limited to: fire alarm, intrusion, security, CCTV, and paging systems.

B. Related documents: The contract documents, as defined in Section 011000-Summary of Work, apply to work of this section. Additional requirements and information necessary to complete the work of this section may be found in other documents.

C. Related sections:
   1. Section 160500 – Common Work Results for Electrical.
   2. Section 162413 – Switchboards.
   3. Section 164113 – Lightning Protection for Structures.
   4. Section 165600 – Exterior Lighting.
   5. Section 175116 – Public Address Paging Systems.
   6. [Section 182304 – Security, Burglary and Robbery Countermeasures Analog CCTV System.]
   7. [Section 182305 – Integrated Security and Investigative Platform (ISIP) CCTV System.]
   8. Section 183100 – Fire Detection and Alarm.

1.2 REFERENCES

A. As specified in Section 160500 – Common Work Results for Electrical.

B. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits,

C. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits,

D. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.

E. NFPA 70; National Electrical Code: Article 285

F. UL 1283 - Electromagnetic Interference Filters

G. UL 1449, Third Edition, effective September 29, 2009 – Surge Protective Devices

1.3 SUBMITTALS

A. As specified in Section 160500 – Common Work Results for Electrical.

B. Section 013300 - Submittal Procedures: Procedures for submittals.
   1. Shop Drawings: Indicate outline and support point dimensions, voltage, integrated short circuit ampere rating, and sizes.
   2. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
   3. Certification submitted SPDs are manufactured in the United Sates.
   4. Shall include UL 1449, 3rd edition Listing documentation verifying the following:.
      a. Short Circuit Current Rating (SCCR)
      b. Voltage Protection Ratings (VPRs) for all modes
      c. Maximum Continuous Operating Voltage rating (MCOV)
      d. I-nominal rating (I-n)
      e. Type 1 Device Listing
         1) VPR, MCOV, I-n, and Type 1 information is posted at www.UL.com, under Certifications, searching using UL Category Code: VZCA. SCCRs are posted in manufacturer's UL docs.
         2) UL data and visual inspection takes precedence over manufacturer's published documentation.

C. Section 017704 - Closeout Procedures and Training: Procedures for closeout submittals:
   1. Project Record Documents: Record actual locations of Products.
   2. Operation and Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.4 QUALITY ASSURANCE

A. As specified in Section 160500 – Common Work Results for Electrical.

B. SPDs must be manufactured in the United Sates.

C. Manufacturer Qualifications: Engage a firm with at least ten (10) years experience in manufacturing transient voltage surge suppressors.

D. Manufacturer shall be ISO 9001 or 9002 certified.

E. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

F. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.5 DELIVERY, STORAGE AND HANDLING

A. Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manuals. One (1) copy of this document to be provided with the equipment at time of shipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the Work include the following.
   1. Advanced Protection Technologies, Incorporated, Clearwater, FL (800) 237-4567.
   2. Emerson/Liebert Corporation, Columbus, OH, (800) 877-9222.
   3. Atlantic Scientific Corporation, Melbourne, FL , (800) 544-4737.
   4. Current Technology Inc., Irving, TX, (800) 238-5000.

B. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

2.2 SERVICE ENTRANCE SURGE PROTECTIVE DEVICES (SPDS)

A. Models:
   1. Basis of Design: Advanced Protection Technologies: “TEXAS” Series.

B. Surge Protective Device Description: Replaceable module type complying with UL 1283 and UL 1449 3rd Edition Listed. Provide unit with the following features and accessories:
   1. LED indicator lights for power and protection status.
   2. Audible alarm, with silencing switch, to indicate when protection has failed.
   3. One set of dry contacts rated at 5.0 amperes, 240 volts ac, for remote monitoring of protection status.

C. Short Circuit Current Rating: SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 285.6.

D. SPD Type: SPD shall be UL labeled as Type 1 (verifiable at UL.com), intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

E. In Rating: SPD shall be UL labeled with 20kA Inominal (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Master Label and NFPA 780.

F. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G, and L-L in WYE systems, and L-L, L-G in DELTA Systems.

G. Minimum Single Impulse Surge Current Capability (single pulse rated) per phase shall be.
   1. Single Impulse Surge Current Capacity is to be 300 kA.

H. Connection Means: Permanently wired via internal or external disconnecting means.

I. Protection modes and UL 1449 3rd Edition Voltage Protection Rating for grounded WYE circuits with voltages of 480Y/277, 3-phase, 4-wire shall be as follows:

VOLTAGE	L-N	L-G	N-G
208Y/120V	700V	700V	700V
480Y/277V	1500V	1500V	1500V

J. Install devices at service entrance at load side, with ground lead bonded to service entrance ground.

K. Test unit in accordance with manufacturer’s written instructions.

2.3 DISTRIBUTION SURGE PROTECTIVE DEVICES (SPDS)

A. Models:
   1. Basis of Design: Advanced Protection Technologies: "TEXDS" Series.

B. Surge Protective Device Description: Non-modular type complying with UL 1283 and UL 1449 3rd Edition Listed. Provide unit with the following features and accessories:
   1. LED indicator lights for power and protection status.

C. Short Circuit Current Rating: SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 285.6.

D. SPD Type: SPD shall be UL labeled as Type 1 (verifiable at UL.com), intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

E. In Rating: SPD shall be UL labeled with 20kA Inominal (I-n) (verifiable at UL.com).

F. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G, and L-L in WYE systems, and L-L, L-G in DELTA Systems.

G. Minimum Single Impulse Surge Current Capability (single pulse rated) per phase shall be.
   1. Single Impulse Surge Current Capacity is to be 150 kA.

H. Connection Means: Permanently wired via internal or external disconnecting means.

I. Protection modes and UL 1449 3rd Edition Voltage Protection Rating for grounded WYE circuits with voltages of 480Y/277, 3-phase, 4-wire shall be as follows:

VOLTAGE	L-N	L-G	N-G
208Y/120V	700V	700V	700V
480Y/277V	1500V	1500V	1500V

J. Install devices as close as possible to distribution or branch panelboards.

K. Test unit in accordance with manufacturer's written instructions.

2.4 FIRE ALARM AND SECURITY SYSTEM SURGE PROTECTIVE DEVICES (SPDS)

A. Power Surge Protection
   1. SPD shall be listed or recognized in accordance with UL 1449 Third Edition verifiable by visiting UL.com.
   2. SPD shall provide surge current L-N or L-G mode of protection.
   3. SPD shall be chase
   4. Every mode of protection, shall be protected by internal overcurrent and thermal overtemperature controls.
   5. SPD shall meet or exceed the following criteria:
      a. Minimum surge current capability (single pulse rated) per phase shall be:
         1) 120/240 Panel Application 50kA per phase
      b. UL 1449 3rd Edition listed Voltage Protection Ratings for shall not exceed the following:

VOLTAGE	L-N/L-G	MCOV
120V or 240/120V	600V	150V

   6. SPD shall have a warranty for a period of two years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.

B. Signal line protection
   1. SPD shall be solid state, silicon avalanche diode circuitry for protection from overvoltages on 2 or 4 wire signal lines such as balanced pair telephone, metallic pair telephone, buried and overhead field cable, remote radio equipment, and control systems. Unit shall have an external ground lug or wire. Connect ground lug or wire to protected equipment grounding system with a No. 12 green insulated stranded ground wire as short as possible.
      a. Pins Protected: Pins 4, 5 on the RJ- 45 Interface; Pins 3, 4 on the RJ- 11 Interface
      b. Clamping Voltage: 310 Volts in 500 nsec
      c. Surge Capacity: 1500 Watts for 1 msec;
      d. Protection Mode:
         1) Common Mode Pins 4, 5 to shielding braid
         2) Differential Mode Pins 4,5
      e. Shall be listed to UL497A Telco Specification

C. Video 75 ohm coaxial cable
   1. Solid state, silicon avalanche diode circuitry for non-interrupting overvoltage protection of RG-59/U coaxial cable. Unit shall be provided with one female input connector for "F" series male connector, one output RG-59/U coax cable terminated with an "F" series male cable end connector and A #16 stranded, 18 inch long grounding wire on output end of unit or similar arrangement. Securely mount adjacent to protection equipment and ground to equipment or local building ground if an equipment ground is not available.
      a. Normal Operating Characteristics
         1) Voltage .....5.8V max
         2) Current.....500ma max
         3) Frequency.....DC to 10 Mhz
         4) Insertion Loss.....3.5db @ 4Mhz
      b. Protection Requirements
         1) Transient suppression level.....7.5v Voltage Protection Level
         2) Transient response.....<5 nanoseconds
         3) Operating temp.....-20° C to +50° C
         4) Energy dissipation.....15,000 watts (10X1000 Test Wave)

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 160500 – Common Work Results for Electrical.

3.2 INSTALLATION

A. The installation shall meet the following criteria:
   1. Install per manufacturer's recommendations and contract documents.
   2. Install units plumb, level and rigid without distortion
   3. One primary lightning arrestor shall be installed external to the service entrance in accordance with manufacturer instructions.
   4. Service Entrance SPD shall be installed on the load side of the main service disconnect.
   5. Service Entrance SPD ground shall be bonded to the service entrance ground.
   6. At Service Entrance, a UL approved disconnecting means shall be provided as a means of servicing.
   7. One SPD shall be installed external to each designated distribution panelboard.
   8. At Distribution and Branch, SPD shall have an independent means of disconnect such that the protected panel remains energized. A 30A breaker (or larger) may serve this function.
   9. SPD shall be installed per manufacturer's installation instructions with lead lengths as short (less than 24") and straight as possible. Gently twist conductors together.

10. Before energizing, installer shall verify service and separately derived system Neutral to Ground bonding jumpers per NEC.

3.3 ADJUSTMENTS AND CLEANING

A. Remove debris from SPD and wipe dust and dirt from all components.

B. Repaint marred and scratched surfaces with touch up paint to match original finish.

3.4 FIELD QUALITY CONTROL

A. As specified in Section 160500 – Common Work Results for Electrical.

B. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacture's recommendations.

C. Check all installed panels for proper grounding, fastening and alignment.

END OF SECTION

SECTION 16870

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Panelboards.

B. Related Documents: The Contract Documents, as defined in Section 011000 - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other documents.

C. Related Sections:
   1. As specified in Section 160500 - Common Work Results for Electrical.

1.2 REFERENCES

A. As specified in Section 160500 - Common Work Results for Electrical

B. National Electrical Manufacturers Association (NEMA):
   1. NEMA AB 1 - Molded Case Circuit Breakers.
   2. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
   3. NEMA KS 1 - Enclosed Switches.
   4. NEMA PB 1 - Panelboards.
   5. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

C. Underwriters Laboratories (UL):
   1. UL 486 - Molded Case Circuit Breakers.
   2. UL 67 - Heat Rise Test for Panelboards.
   3. UL 50 - Steel Gauge Requirements for Cabinets and Enclosures.
   4. UL 1449 3rd Edition - Standard for Transient Voltage Surge Suppressors.

1.3 SUBMITTALS

A. As specified in Section 160500 - Common Work Results for Electrical.
   1. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
   2. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
   3. Shall include UL 1449 Listing documentation verifying the following:
      a. Short Circuit Current Rating (SCCR)
      b. Voltage Protection Ratings (VPRs) for all modes
      c. Maximum Continuous Operating Voltage Rating (MCOV)
      d. I-nominal rating (I-n)

B. Section 017704 - Closeout Procedures and Training: Procedures for closeout submittals:

1. Project Record Documents: Record actual locations of Products; indicate actual branch circuit arrangement.
2. Operation and Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
3. Submit data showing compliance with UL 1449.

1.4 QUALITY ASSURANCE

A. As specified in Section 160500 - Common Work Results for Electrical.

B. Qualifications
1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

PART 2 - PRODUCTS

2.1 GENERAL CLASSIFICATION

A. Manufacturers: General Electric Company (G.E.) Catalog numbers are used to identify type of equipment specified. Equivalent products by the following manufacturers are acceptable: Alternate substitutions not permitted.
1. Siemens
2. Square-D
3. Eaton/Cutler Hammer
   a. Branch Circuit Panels:
      1) 120/208V: G.E. Type AQ
   b. Distribution Panels:
      1) Circuit breaker: G.E. Type CS or A

2.2 PANELBOARDS

A. Cabinet: Construct cabinet with code gauge galvanized steel. Provide minimum 20 inch wide cabinets, and extra wiring space where incoming feed-through or parallel lines are required.

B. Doors: Provide single door construction, made of cold-rolled steel. Door shall have concealed hinges, flush catch, and lock. (Tie bar handles not acceptable). Secure top and bottom of door to cabinet by slotted steel bolts. Release shall be by one-half turn with a screwdriver. All panels shall be keyed alike.

C. Panels located adjacent to each other shall have identically sized enclosures and trims.

D. Finish: Finish exposed parts with one coat of primer and one coat of light gray enamel suitable for overpainting in field if desired.

E. Phase, neutral and ground bus bars shall be tin plated copper.

F. Provide all hardware for future breakers, identified on drawings as SPACES, or for the full length of usable bus, whichever is longer.

G. Provide ground bus with full complement of terminals in addition to insulated neutral bus.

H. Circuit Breakers:
1. Provide multi-pole units with common trip elements. Handle ties are not acceptable.

2. Provide key-operated circuit breakers in the panelboards used for the Fire Alarm. Security and CCTV Systems. Circuit breakers shall be similar to square D type QO_K.
3. 120/208V branch circuit panelboards: Molded cast bolt-on type designed for 120/208V, three phase, four wire service with minimum 10,000 amperes rms short circuit rating.
4. 277/480V branch circuit panelboards: Molded cast bolt-on type designed for 277/480V, three phase, four wire service with minimum 14,000 amperes rms short circuit rating.

I. Main circuit breakers shall be individually mounted. The panelboard interior assembly shall be dead front with panelboard front removed. Main lugs or main breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the main shall have barriers.

J. Provide all panelboards with lockout/tagout devices; Circuit-Safe type as manufactured by Stranco, Inc. or approved equal.

K. Nameplates: Provide screwed-on (no adhesives) engraved bakelite nameplate identification on outside of each panel showing panel designation, voltage and phase in minimum ¼ inch high letters.

L. Circuit directories: Provide a metal-framed typewritten circuit directory on inside of inner door, with plastic protector.

M. Provide 2-3/4 inches and 1-1 inch spare empty conduits routed above into accessible ceiling space from all flush mounted panelboards.

N. Panels serving electronic equipment and/or other harmonic producing loads shall be equipped with double neutral bus bars.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 160500 – Common Work Results for Electrical.

3.2 CLEARANCES

A. Minimum code required clearances around panelboards must be maintained.

3.3 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1.

B. Install panelboards plumb. Provide supports in accordance with Section 160500.

C. Provide filler plates for unused spaces in panelboards.

3.4 MOUNTING HEIGHT

A. Typically mount panel boards top at 6 ft. – 0 in. above finished floor but no more than 6 ft. – 6 in. above finished floor to top of circuit breaker handle.

3.5 MOUNTING HARDWARE

A. Provide all necessary blocking, channels and other hardware for securing panelboards to wall, column, or other parts of building structure.

3.6 FIELD QUALITY CONTROL

A. As specified in Section 160500 – Common Work Results for Electrical.

B. Inspect and test panelboard installation and torque connections.

C. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

D. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.

END OF SECTION

SECTION 16880

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior luminaires and accessories.
   2. Emergency lighting units.
   3. Exit signs.
   4. Ballasts.
   5. Lamps.
   6. Luminaire accessories.

B. Substitutions:
   1. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Not allowed.

C. Related Documents: The Contract Documents, as defined in Section 011000 - Summary of Work, apply to the work of this section. Additional requirements and information necessary to complete the work of this section may be found in other documents.

D. Related Sections:
   1. As specified in Section 160500 - Common Work Results for Electrical

1.2 REFERENCES

A. As specified in Section 160500 – Common Work Results for Electrical.

B. American National Standards Institute (ANSI):
   1. ANSI C78.379 - Electric Lamps - Incandescent and High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns.
   2. ANSI C82.1 - Ballasts for Fluorescent Lamps - Specifications.

C. National Electrical Manufacturers Association (NEMA):
   1. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

D. Federal Communications Commission Parts 18.305, 18.307 (EMI RFI)

1.3 SUBMITTALS

A. As specified in Section 160500 – Common Work Results for Electrical.
   1. Product Data: Provide dimensions, ratings, and performance data for each fixture specified.
   2. Assurance/Control Submittals:
      a. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

B. Section 017704 - Closeout Procedures and Training: Procedures for closeout submittals:
   1. Operation and Maintenance Data: Submit manufacturer's operation and maintenance instructions for each type of fixture.

1.4 QUALITY ASSURANCE

A. As specified in Section 160500 - Common Work Results for Electrical.

1.5 MAINTENANCE

A. Section 017704 - Closeout Procedures and Training: Procedures for closeout submittals.

B. Extra Products: At completion of installation, deliver to Contracting Officer.
   1. Two of each luminaire lens type.
   2. Each component type: Provide quantity for each unique ballast, relay, I/O module and lamp equal to 2 percent of fixture total, but not less than two of each type.

PART 2 - PRODUCTS

2.1 LUMINAIRE MANUFACTURERS

A. Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:
   1. Belfer Group, Farmingdale, NJ (732) 493-2666
   2. Canlet/Canplas Industries, Ltd., Denver, CO (303) 373-1918
   3. Chloride Systems, Burgaw, NC (910) 259-1000.
   4. Cooper Lighting (Halo, Invue, Lumark, Metalux, Portfoliom Sure-Lites), Peachtree City, GA (770)486-4800.
   5. Day-Brite, Tupelo, MS (662) 842-7212.
   6. Dual-Lite, Cheshire, CT (203) 699-2000.
   7. Edison-Price Lighting, Long Island City, NY (718) 685-0700.
   8. Elcast Lighting, Addison, IL (630) 543-5390.
   9. Fostoria Process Equipment, Chicago, IL (800) 495-4525.
   10. Gardco Lighting, San Leandro, CA (800) 227-0758.
   11. GE Lighting Systems, Charlotte, NC (803)462-2016
   12. Gotham Lighting, Conyers, GA (800) 315-4982.
   13. Guth Lighting, St. Louis, MO (314) 533-3200.
   14. H.E.Williams, Carthage, MO (417) 358-4065.
   15. Holophane, Newark, OH (740) 345-9631.
   16. Hubbell Lighting, Inc., (Columbia, Spaulding, Sterner) Spartanburg, SC (864) 599-6000.
   17. Indy Lighting, Fishers, IN (817) 849-1233.
   18. Kenall Manufacturing, Gurnee, IL (847) 360-8200.
   19. Kirlin Lighting, Detroit, MI (313) 259-6400.
   20. Kramer Lighting, Sturtevant, WI (800) 236-6800.
   21. Kurt Versen Company, Westwood, NJ (201) 664-8200.
   22. LaMar Lighting, Farming Dale, NY (631) 777-7700.
   23. LightAlarms (Thomas & Betts) Montreal, ON (888) 552-6467.
   24. Lighting Alternatives, Cherry Hill, NJ (877)847-1102
   25. Lightolier, Fall River, MA (508) 679-8131.
   26. Lithonia Lighting, Conyers, GA (770) 922-9000.
   27. Lumux Lighting, Inc., Sacramento, CA (877) 895-5552.
   28. Nulite, Denver, CO (303) 287-9646.
   29. Omega Lighting, Tupelo, MS (800) 234-1890.
   30. Optimum Lighting, Henderson,NC (800)541-9082
   31. Phoenix Products, Milwaukee, WI (414) 438-1200.
   32. Prescolite Lighting, Spartanburg, SC (864) 599-6000.
   33. Vista Lighting, Tupelo, MS (662) 690-4105.

34. Zumtobel Staff, Highland, NY (800) 448-4131.

2.2 LUMINARIES

A. Refer to luminary schedule shown on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 160500 – Common Work Results for Electrical.

3.2 INSTALLATION

A. Install suspended luminaires and exit luminaire signs using pendants supported from swivel hangers, as applicable, or wire rope from ceiling structure, as applicable, or in accordance with details shown on drawings. Provide pendant/wire rope length required to suspend luminaire at indicated height.

B. Support grid mounted, recessed fluorescent fixtures at each corner using a minimum of four wire hangers of same gauge as ceiling suspension system supported from building structure independent of ceiling framing.

C. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

D. Install surface mounted luminaires and exit luminaire signs plumb and adjust to align with building lines and with each other. Secure to prevent movement. Mount exit signs to outlet box mounted flush in wall or ceilings. Outlet box for ceiling mounted exit signs: Connect to rigid conduit system.

E. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure.

F. Install recessed luminaires to permit removal from below.

G. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating. In fire rated ceilings recessed luminaires must carry 1 hour UL fire rating classification.

H. Install earthquake clips to secure recessed grid-supported luminaires in place.

I. Install wall mounted luminaires, emergency lighting units and exit luminaire signs at height as scheduled.

J. Install accessories furnished with each luminaire.

K. Bond products and metal accessories to branch circuit equipment grounding conductor.

L. Install specified lamps in each emergency lighting unit, exit luminaire sign, and luminaire.

3.3 FIELD QUALITY CONTROL

A. As specified in Section 160500 – Common Work Results for Electrical.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

C. Final acceptance for areas larger than 10,000 sq. ft. will be based on measurement of initial lighting levels after required hours of burn in as specified in USPS Customer Service Facilities Design Criteria, not maintained lighting levels.

3.4 ADJUSTING

A. Aim and adjust luminaires as directed by Contracting Officer.

B. Position exit luminaire sign directional arrows as indicated.

3.5 CLEANING

A. Conform to Section 017300 - Execution: Cleaning installed work.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

F. Relamp any fixtures with defective or burned out lamps, just prior to Final Acceptance.

END OF SECTION

SECTION 16890

EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior luminaires and accessories.
   2. Poles.
   3. Ballasts

B. Related Documents: The Contract Documents, as defined in Section 011000 - Summary of Work, apply to the work of this section. Additional requirements and information necessary to complete the work of this section may be found in other documents.

C. Related Sections
   1. As specified in Section 160500 - Common Work Results for Electrical.
   2. Section 033000 - Cast-in-Place Concrete.

1.2 REFERENCES

A. As specified in Section 160500 – Common Work Results for Electrical.

B. American National Standards Institute (ANSI):
   1. ANSI C78.379 - Electric Lamps - Incandescent and High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns.
   2. ANSI C82.4 - Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple-Supply Type).

C. Illuminating Engineering Society (IES):
   1. IES RP-8 - Recommended Practice for Roadway Lighting.
   2. IES RP-20 - Lighting for Parking Facilities.

D. Federal Communications Commission Parts 18.305, 18.307 (EMI RFI)

1.3 SUBMITTALS

A. As specified in Section 160500 – Common Work Results for Electrical.
   1. Product Data:
      a. Fixture dimensions, ratings, and performance data.
      b. Complete computer data printout of illumination levels based on a 5 ft. by 5 ft. grid pattern.
   2. Shop Drawings:
      a. Indicate dimensions and components for each luminaire which is not a standard Product of the manufacturer.
      b. Indicate illumination levels in accordance with layout and scheduled luminaires indicated on Drawings.

1.4 QUALITY ASSURANCE

A. As specified in Section 160500 – Common Work Results for Electrical.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Material and Equipment: Transport, Handle, Store, and Protect Products.

1.6 MAINTENANCE

A. Section 017704 – Closeout Procedures and Training. Procedures for closeout submittals.

B. Extra Products: At completion of installation, deliver to Contracting Officer.
   1. Each component type: Provide quantity for each unique ballast, surge protector and lamp equal to two (2) percent of fixture total, but not less than two of each type.

PART 2 - PRODUCTS

2.1 LUMINAIRE MANUFACTURERS

A. Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:
   1. Refer to lighting schedule on drawings.

B. Substitutions:
   1. Section 016000 – Product Requirements: Product options and substitutions, substitutions permitted.

2.2 Luminaire Types

A. Refer to lighting schedule on drawings

2.3 POLES

A. Manufacturers:
   1. As listed in paragraph 2.1A.

   2. Section 016000 - Product Requirements: Product options and substitutions. Substitutions: Permitted.

B. Material and Finish: Aluminum. Finish by contracting officer.

C. Section Shape and Dimensions: Refer to drawings.

D. Height: 25 feet, (7.62 m).

E. Base: Nonbreakaway.

F. Accessories:
   1. Handhole.
   2. Anchor bolts.
   3. Base Cover.
   4. Bolt covers.
   5. Ground rod and conductor.

G. Approximate Loading Capacity Ratings:
   1. Luminaire Weight: 35 pounds.
   2. Luminaire and Bracket Effective Projected Area: 1.5 square feet.
   3. Steady Wind: 150 miles per hour minimum, with gust factor of 1.3.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 160500 – Common Work Results for Electrical.

3.2 INSTALLATION

A. Provide 3000 PSI minimum concrete for lighting pole bases at locations indicated, in accordance with Section 033000 and details shown on drawings.

B. Install poles plumb and provide double nuts to adjust plumb. Grout around each base and provide bolt covers.

C. Install lamps in each luminaire.

D. Bond luminaires, metal accessories and metal poles to branch circuit equipment grounding conductor. Provide supplementary 3/4 inch x 10 foot copper clad rod with #2 AWG copper grounding electrode at each pole.

3.3 FIELD QUALITY CONTROL

A. As specified Section 160500 - Common Work Results for Electrical.

B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

C. Measure illumination levels to verify conformance with layout and performance requirements.

D. Take measurements during night sky, without moon or with heavy overcast clouds effectively obscuring moon.

3.4 ADJUSTING

A. Aim and adjust luminaires to provide illumination levels and distribution as directed.

3.5 CLEANING

A. Conform to Section 017300 - Execution: Cleaning installed work.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosure, pole and base.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.6 PROTECTION OF FINISHED WORK

A. Conform to Section 017300 - Execution: Protecting installed work.

B. Relamp or re-ballast luminaires with defective or burned out lamps, just prior to final acceptance.

END OF SECTION